APPLIED
HYDRAULICS
THE MAGAZINE OF FLUID POWER | Air Circuits • Electrical Controls

MAY 1957

LEAKAGE CONTROL

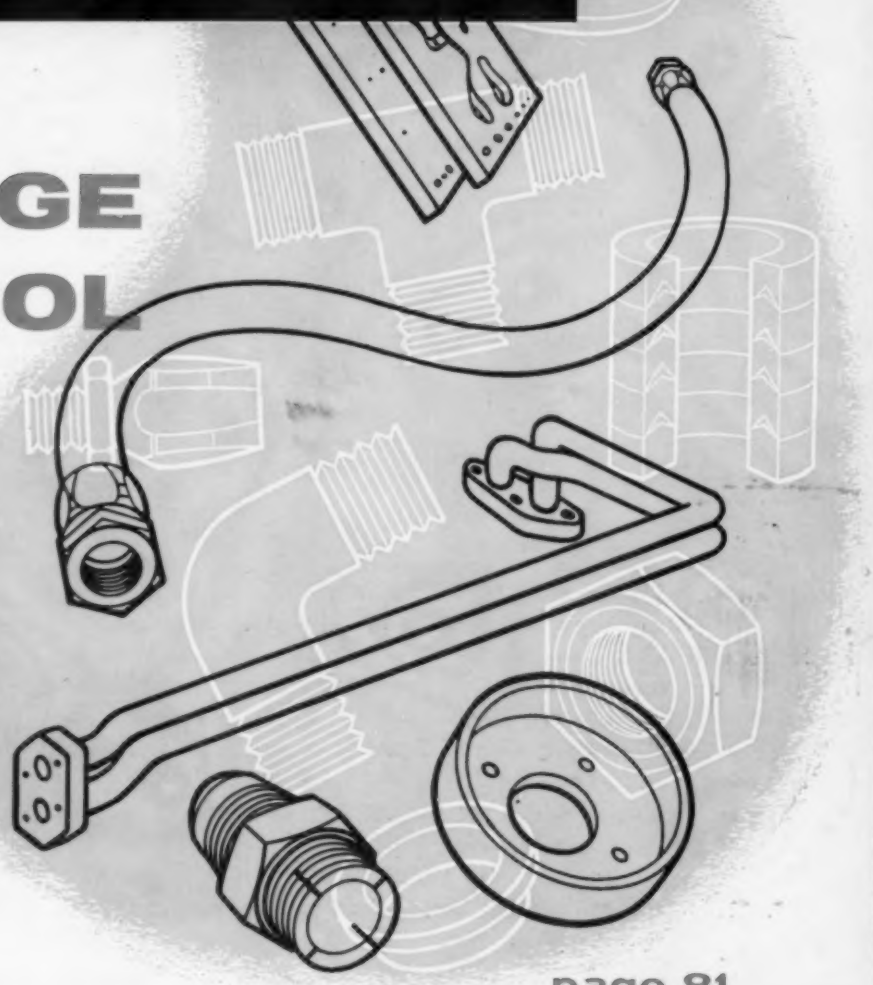
User Survey

Port Seal Progress

Packing Developments

Installation Methods

Piping Ideas



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JULY 1st, 1957

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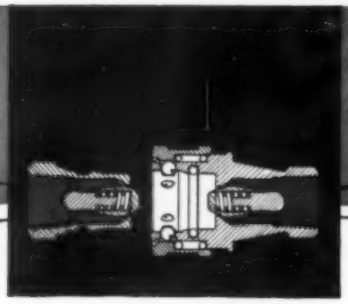

shuts off both sides of line... prevents loss of liquid, gas, or pressure.

Wherever 2-way shut-off is required...

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FOR PRESSURE OR VACUUM SERVICE

To connect a Hansen Two-Way Shut-Off Coupling, you merely pull back the sleeve and push the Plug into the Socket. To disconnect, just pull back the sleeve. No tools required. When Coupling is disconnected, similar valves in Socket and Plug shut off both ends of line—practically eliminate spilling of liquid or escape of gas at instant of disconnection.

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WRITE FOR THE HANSEN CATALOG

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SINCE 1915 ® QUICK-CONNECTIVE FLUID LINE COUPLINGS

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CONTROL FLUID FLOW

with Micrometer Accuracy

HANNA *Flo-Set* VALVES

For AIR, OIL and WATER operation to 250 p.s.i.
SIZES ¼" • ⅜" • ½" • ¾"
TEMPERATURES to 250°F

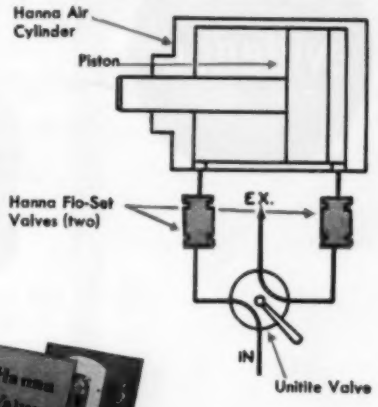
Hanna Flo-Set Valves are used to control cylinder piston speeds and operating speeds of many types of fluid actuated mechanisms. They are able to handle air, oil, water and many gases. When used with cylinders, these valves permit independent adjustments of forward and return piston speeds. The diagram at the right shows a typical circuit. Flo-Set Valves make the operation of air cylinders smoother and make cushioned cylinders more effective by building up essential back pressure.

Fluids pass unobstructed in the direction of the arrow on Hanna Flo-Set Valves. In the opposite direction, flow can be controlled from zero to full pipe capacity. One valve can be set to an infinite number of controlled flow positions. Once set, the position can be held by means of a locking collar. Established flow positions can be reset by using the micrometer graduations which accurately measure flow as a percent of full pipe capacity.

One revolution of the aluminum valve body will change the flow rate from zero to full capacity. No tools are necessary! In addition to the standard ¼", ⅜", ½" and ¾" sizes, there is a ¼" Jr. model, without micrometer graduations or locking collar, for light piping and tubing.

Typical Cylinder Circuit Using Hanna Flo-Set Speed Control Valves

Hanna engineers will gladly recommend circuits to help you with your applications.



Consult your classified telephone directory or Thomas' Register for your nearest Hanna representative. Write for Hanna Valve Catalog 254 and Flo-Set Valve Bulletin 253A.

Hanna Engineering Works

HYDRAULIC AND PNEUMATIC EQUIPMENT... CYLINDERS ... VALVES ... RIVETERS

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problem:

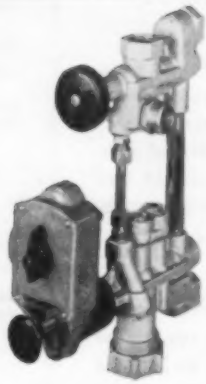
find a low-friction seal that positively seals at extremely low pressures

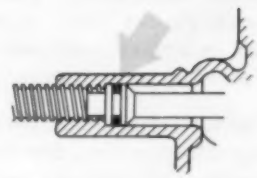
new answer:

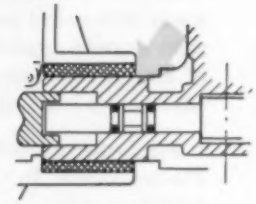
minnesota rubber's money-saving new

QUAD® RING

evidence:







THE LINDSAY COMPANY, world's largest manufacturer of automatic home water softeners, uses three QUAD RINGS in its newest valve. Lindsay tested O-rings in the valve, but O-rings leaked at very low pressures. Then Lindsay tested QUAD RINGS, a revolutionary new seal originated and manufactured by Minnesota Rubber. QUAD RINGS sealed perfectly no matter how low the pressure. The Lindsay Company also found that it could open some of the tolerances on the valve parts—and save money—because QUAD RINGS give such a good seal with low friction.

QUAD RINGS are injection molded. Denser, tougher. 4-lip action even seals at less than 1 psi! Only 60-100 micro-inch groove finish needed. No parting line on sealing surface. Eliminates "spiral twist".

QUAD RING is a Minnesota Rubber and Gasket Company trade mark

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APPLIED
HYDRAULICS
THE MAGAZINE OF FLUID POWER

MAY 1957 • VOLUME 10, NO. 5

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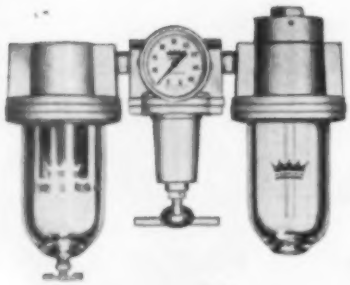

NEW *Crown* BULLETINS TELL HOW...

Hannifin's newest development, the Crown Line of FILTERS, REGULATORS and LUBRICATORS, saves money wherever air power is used. The filters remove dirt and scale without robbing you of precious power. The regulators let more air through when it's needed than other regulators do. The lubricators operate on minimum pressure differential —they are quicker and easier to fill, too. Available now—local, distributor stocks in many areas. Write for bulletins and for name of nearest distributor.

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Bulletin 301

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Bulletin 302

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Position.....

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City.....*State*.....

APPLIED HYDRAULICS — THE MAGAZINE OF FLUID POWER

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BPA

No Gaskets, Sealing Compounds or Tapered Threads

when you use

ANCHOR FLANCO

4-Bolt, Split-Flange Couplings

The higher the pressure the tighter the seal

The "O" Ring does the trick!

You can disconnect and reconnect hose lines time after time without leaks — there are no threads to wear out, no tapered seats to groove, when you use Anchor FLANCO Split Flange Couplings.

Costly pipe threading operations, and separate union and swivel connectors are eliminated — production costs are cut.

The patented Split-Flange permits easy removal and replacement of the hose assembly, particularly in close quarters.

Anchor Split-Flange Couplings are available with pressed-on hose assemblies for original equipment —Anchor Clamp Type Couplings for special unit assembly or immediate repair — and Anchor Weld-Type fittings for pipe or tubing.

Flanco Split Flange Couplings conform to SAE Standards, 1957, SAE Handbook.

For the complete story on Anchor FLANCO Split-Flange Couplings—write today for Anchor Catalog 401.

Andy Anchor says:

The following catalogs describing Anchor Couplings and Hose Assemblies contain much helpful engineering data. Send for them today.

Catalog No. 100—Anchor Pressed On Hose Assemblies.

Catalog No. 202 —Anchor Adapter Unions, Pipe Fittings and new SAE Boss Type Adapters — see SAE Standards, 1957, SAE Handbook.

Catalog No. 301 — Anchor Reusable Couplings.

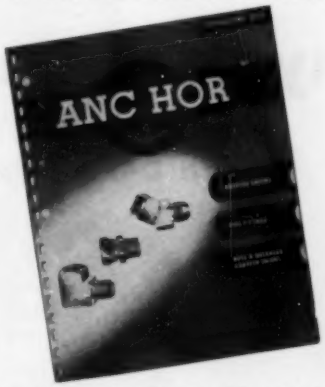
ANCHOR COUPLING CO. INC.

356 North Fourth Street • Libertyville, Illinois

Branch Offices: Dallas, Tex.; Plymouth, Mich.

Useful Literature

COMPLETE ENGINEERING DATA ON ANCHOR ADAPTER UNIONS, PIPE FITTINGS, AND SAE STRAIGHT THREAD "O" RING BOSS TYPE FITTINGS



The new Anchor Catalog No. 202, just off the press, contains the information needed by the hydraulic engineer to plan his hydraulic connections. Flow charts for adapter unions and fittings, formulas for calculating hose lengths and data on threads are given as well as specifications on the complete line of Anchor Adapter Unions, Pipe Fittings and the new, complete Anchor Line of SAE Straight Thread "O" Ring Boss Type Adapters and Fittings.

With these new SAE Boss Type Fittings, danger of thread distortion or damage to valve bodies is eliminated by the straight thread design. Use of the "O"-Ring Seal insures a positive leak-proof seating without excessive tightening, and permits loosening and retightening many times without leaks. Also shown in Catalog No. 202 is a new and complete line of Anchor Tube Nuts available in several styles and sizes.

The Anchor Line of Adapter Unions, Tees and Crosses is very complete as to size range and style of fitting. They are designed for use with pressed-on or reusable hose assemblies and provide a ground joint, leak-proof connection. By using them, one or more pipe thread joints are eliminated, and assembly in confined spaces is facilitated.

The new Catalog No. 202 may be had by writing to Anchor Coupling Co. Inc., 356 North Fourth Street, Libertyville, Illinois.

FROM DENISON

How Caterpillar designs rugged hydraulic efficiency into Traxcavator

with Denison's new 2000 psi vane-type hydraulic pump

• Rugged dependability and high operating efficiency have been engineered into Caterpillar's new No. 977 Traxcavator with Denison's balanced-vane hydraulic pump.

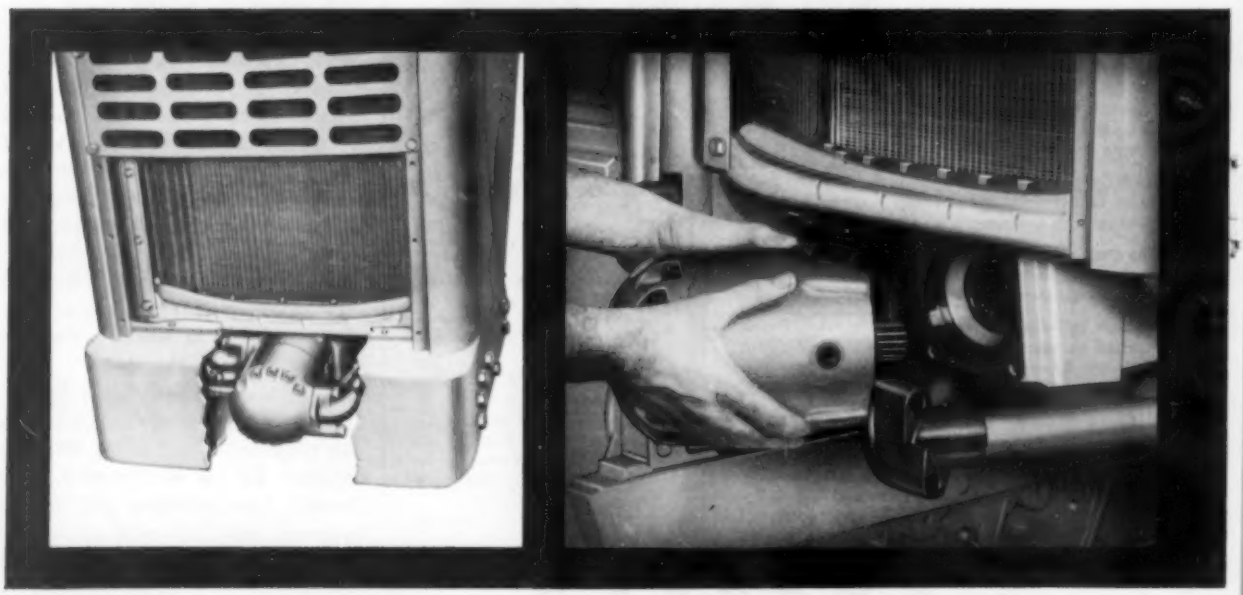
Capable of delivering continuous 2000 psi service, the Denison pump powers the Traxcavator's lifting arms—the real workers on construction equipment of this type. The pump contributes these important design features.

Packs more power . . . 50 h.p. in less space than a conventional 3 h.p. electric motor where weight and space are a premium.

Cold-weather starting . . . under severe weather conditions, to help maintain construction schedules, avoid costly delays.

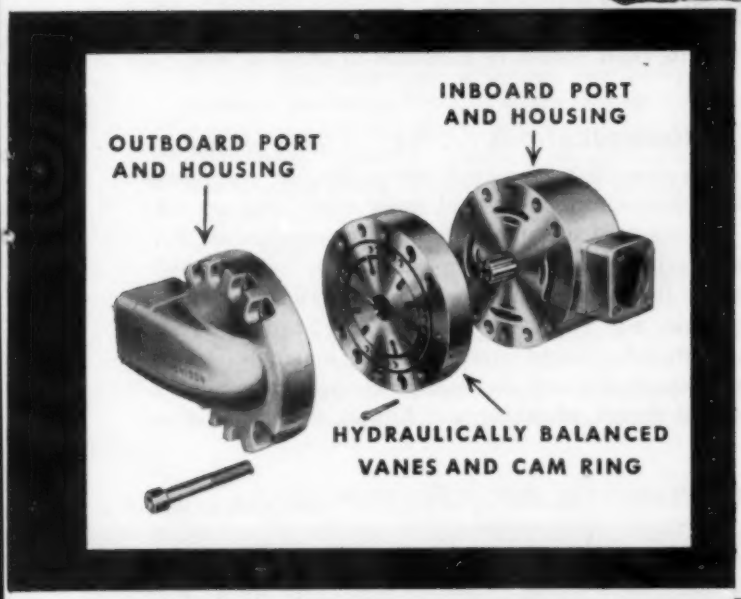
Fast on-the-job servicing . . . pump easily removed and replaced as a unit without special tools or skills.

Long, efficient life . . . fully-balanced vanes and rotors reduce wear on cam rings and thrust plates to give long pump life with minimum maintenance. Internal friction is lower, volumetric efficiency higher. In the Traxcavator, the pump is operated at 1700 psi, further increasing its lifespan.



Denison 2000 psi vane-type hydraulic pump, located at front of engine, is driven through a universal joint.

Complete pump is removable as a unit to simplify servicing in the field. Special tools or skills are not required.



Denison's exclusive cartridge construction. Rugged, specially designed vanes provide dual sealing edges between vane and cam ring.

***NEW* BULLETIN 200** describes how Denison's 2000 psi hydraulic pump can improve the design and operation of all types of mobile equipment and machinery. Write Denison Engineering Division, American Brake Shoe Co., 1166 Dublin Road, Columbus 16, Ohio.

DENISON Hydr OILics

HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

Fluid Power Lines

about Applied Hydraulics

WHITHER LEAKAGE . . . For the last five months, the editors of AH have been studying the causes of hydraulic and pneumatic leakage and what can be done to correct it. This issue, devoted entirely to this important problem, is what we've learned. To find out what techniques and components are available, AH invited manufacturers of tube fittings, packings, hose fittings and assemblies, and other components to contribute information on their products with emphasis on ability to control leakage.

We've always been aware of the widespread problem of leakage. Leaks in air circuits often pass as much as a 1/8-inch hole. Oil leakage in one plant amounts to 60% of the oil usage.

Because leakage control starts on the drawing board, this issue is of particular value to designers. Copies of this issue will be available at the Design Engineering Show in New York during the week of May 20th.

ME TOO . . . We know of 80 manufacturers of fluid power packings, 45 producers of hose assemblies, and 22 companies who make tube fittings. Obviously not everyone's complete line could be described in this issue—important as the items may be in controlling leakage. We've tried to cover the main types of components that have been effective and to indicate some of the newer types that have been developed. Keeping a careful watch for new products, such as reported in our monthly New Products department, is part of every designer's job.

NFPA EFFORTS . . . The National Fluid Power Association, an organization of hydraulic and pneumatic component manufacturers, has an active technical board tackling problems of ratings and standards. The board is now developing a chart indicating port seal characteristics of importance to users. It will show how the various types compare. This chart should be available in about a year.

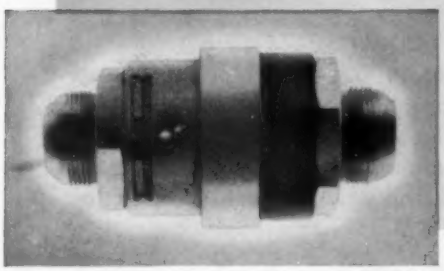
JIC RECOMMENDATIONS . . . "JIC" is in the vocabulary of every manufacturer supplying production equipment to the automotive industry and many others who are taking advantage of the standards of this organization. Primary purpose of the group has been to set up standards for industrial equipment incorporating hydraulic, pneumatic, and electrical systems. The Standards are aimed toward reduced down-time and maximum safety. Some important points on leakage control concern packings, seal design, plumbing and fittings, and installation.

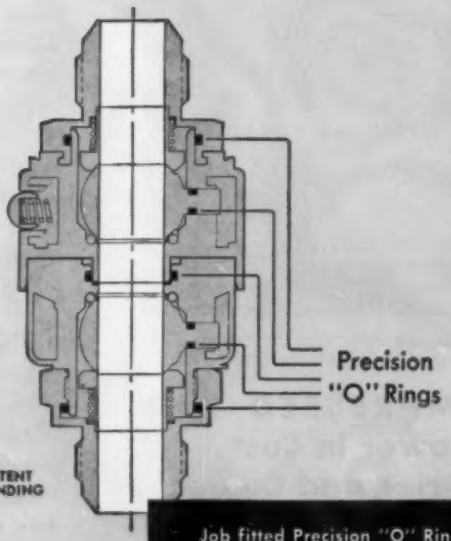
LEFT UNSAID . . . Inevitably in a special issue such as this, many things must be left unsaid—there's just no room. Many other components and techniques are available to fight leakage. Packing design is a field in itself; port seals are in a state of rapid development. AH has reported on many of these in the past and will continue in the future. If you've got some special tricks, let us know.

ZERO LEAKAGE

Precision "O" Rings answer another sealing problem

Precision "O" Rings in the Eastern Aircraft quick disconnect coupling seal perfectly under pressure of 4000 P.S.I. and over the temperature range of −65° to 275°F.





Job fitted Precision "O" Rings have solved hundreds of other industrial aircraft and automotive sealing problems.

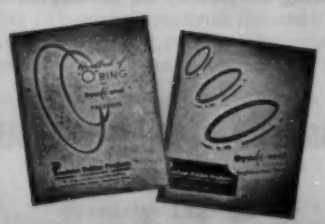
Rigid quality controls maintained at Precision are paying off both for Precision and their customers. A case in point is the development of a quick disconnect coupling by Eastern Aircraft Products Corporation of Orange, New Jersey. Precision engineers developed "O" Ring compounds for these straight through couplings which eliminate pressure drop, and provide zero leakage. The result—a super quick, self-sealing, trouble-free coupling sealed at both ends for the aircraft, petroleum and chemical industries.

"O" Rings are compression molded at Precision to meet specific requirements. They are rigidly inspected—meet all military and commercial specifications—the finest made!

What is your sealing problem? There is an expert—the Precision engineer—ready to help you in product design and "O" Ring specifications. You can rely on him, and on Precision, the world's largest exclusive manufacturer of "O" Rings.

Precision "O" Rings in Kepner Products "Kep-O-Seal" Check Valves effectively seal against external and internal leakage. Positive action from 1 to 5000 PSI, in temperature range of −40 F to 280 F.

Write for your free copies of Precision catalogs on "O' Rings and Dyna-seals



Precision Rubber Products
Corporation • "O" Ring and Dyna-seal Specialists

Dept. 1, Oakridge Drive, Dayton 7, Ohio

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Circle 121 on Reader Service Card

This Niagara Aero After Cooler also cools compressor jacket and intercooler water.

COMPRESSED AIR
• Lower in Cost
• Drier and Cooler

THE NIAGARA *AERO* AFTER COOLER offers a completely self-contained method replacing both shell-and-tube cooler and cooling tower. It is independent of a large supply of cooling water and consistently reduces compressed air temperatures to below ambient.

Drier air gives you better operation and lower costs in using all air-operated automatic instruments, tools and machines, paint spraying, sand blasting and moisture-free air cleaning.

Direct saving in the cost of cooling water saves the price of the Niagara *Aero* After Cooler in less than two years.

Niagara *Aero* After Cooler assures all these benefits because it cools compressed air or gas below the temperature of surrounding atmosphere; there can be no further condensation in your air lines. It condenses the moisture by passing the air through a coil on the surface of which water is evaporated, transferring the heat to the atmosphere. It is installed outdoors, protected from freezing in winter, proven in service on the largest plant utility systems.

Write for Bulletin No. 130

NIAGARA BLOWER COMPANY
Dept. AH-5, 405 Lexington Ave.
NEW YORK 17, N. Y.
District Engineers in
Principal Cities of U. S. and Canada

Fluid Power Lines

continued

DO IT YOURSELF . . . Two of the articles in this month's issue are strictly "how to's" on *Installing Fluid Power Lines* and *How To Install A Packing*. These are intended not only for the pipe fitter who actually bends the tubing, forms the flares, and replaces the packings, but also for the designer who originally lays out the machine and designs the components. As Russ Hemeon points out in his article, *Practical Design Ideas*, careful attention to the original design of the machine can go a long way in the solution of the leakage problem.

QUICK, HENRY, THE FLIT . . . One way to deal with a pest is to *eliminate* him. Lest this sounds like homicide, we're thinking about leaking joints in fluid power lines. Manifolds reduce leakage by eliminating connections which *are* or *can be* leakers. The manifold article on page 94 is a comprehensive review of what types are being used, how they are fabricated, and what materials are effective.

SWEETHEART IN EVERY PORT . . . That's what engineers are looking for in the new straight thread O-ring and metal-to-metal fittings. These and other devices for eliminating leakage at port connections to valves, cylinders, and pumps are outlined in the article on page 90. Most of these devices have been available for only a few years. Some have been in service long enough to prove their value to the user. Others have only recently been announced—in fact, one of the products was introduced while the article was being written.

HOLD THE PRESSES . . . Our editoral office bears little resemblance to the hectic city desk of newpapers. But our efforts to report the very latest in leakage control has played havoc with our publication schedule. Bert Benkendorf who plans the pages of AH has three new gray hairs because of last minute changes which our editors insisted on in the interest of up-to-the-minute reporting.

ALONG THE AISLES . . . In this issue you'll find information on what you can see in Fluid Power at the Design Engineering Show in New York during the week of May 20th. AH will pitch its tent there with Editor Paul Rolnick and Associate Editor Keith Carlson ready to talk shop with all comers.

J&L cold drawn ELECTRICWELD tubing with a superior SPECIAL SMOOTH I.D. finish

Cold drawn ELECTRICWELD tubing with the superior smooth I.D. finish will cut your production costs in applications like these:

- **cylinder tubing**
- **hydraulic and pressure tubing**
- **shock absorbers**
- **ordnance components**

This new drawn-over-mandrel grade tubing with its mirror-like surface finish helps reduce or eliminate costly machining on many applications. For example, it may be used, without inside honing, for many cylinders through which plungers are passed.

ELECTRICWELD tubing withstands high internal hydrostatic pressures; carries heavy torsion loads; resists high-frequency vibration. It offers a favorable weight-to-strength ratio where loading occurs in all directions.

It is furnished in OD sizes from ½ inch to 2⅞ inches and in wall thickness from 20 to 10 gauge, 0.035 and 0.134 inch. Send coupon today for complete information.

Jones & Laughlin Steel Corporation
Dept. 524, 3 Gateway Center
Pittsburgh 30, Pennsylvania

Send me a copy of your cold drawn ELECTRICWELD tubing booklet.

Name_____

Title_____

Company_____

Address_____

City_____ Zone___ State____

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Jones & Laughlin

. . . a great name in steel

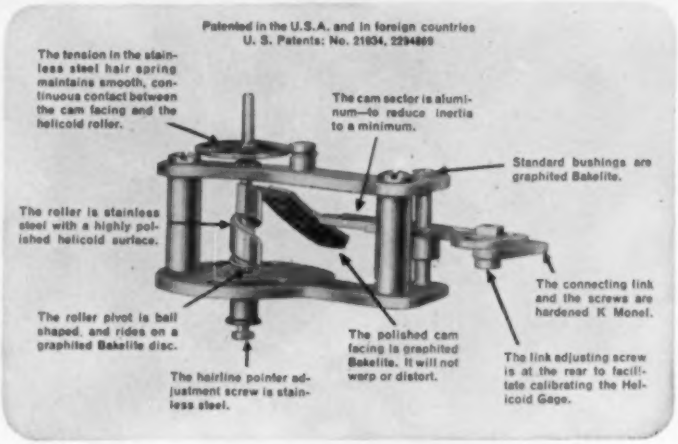
ACCO
Helicoid
Gage
U.S.A.

NOTHING BUT THE BEST IN GAGES FOR WORKING PRESSURES FROM 30" VACUUM TO 10,000 p. s. i.

The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or severe mechanical vibrations.

The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown at the right.

Rolling action of the cam facing against the roller surface . . . graphited Bakelite bushings, roller pivot base and cam facing . . . K Monel connecting links and screws . . . all such Helicoid features protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation through millions of cycles.


Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21634, 2294889
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

EASIEST ADJUSTMENT AND CALIBRATION

Only Helicoid Gages have the external pointer adjustment pictured here. The Helicoid type adjustment cannot be jarred out of position.

Calibration of Helicoid Gages is accomplished easily, without removing dial or pointer, because the link adjusting screw is at the rear of the system.

HELICOID DIALS ARE EASIEST TO READ

Helicoid Gage Standard Dials are well known for quick and easy readability. Tests show that they are easily read at a greater distance than is ordinarily possible.

Dials are furnished jet black with white figure markings or dull white with black figure markings. Standard dials are of laminated phenol with a transparent plastic surface. They are non-corroding, will not discolor, fade, crack, chip or peel and can be cleaned without damage.

TUBES BUILT FOR MILLIONS OF PRESSURE PULSATIONS

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials—alloy steel, K Monel, stainless steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak or crack.

For complete information on the Helicoid line of gages write for **Catalog G-52**

Helicoid Gage Division
AMERICAN CHAIN & CABLE
929-H Connecticut Avenue • Bridgeport 2, Connecticut

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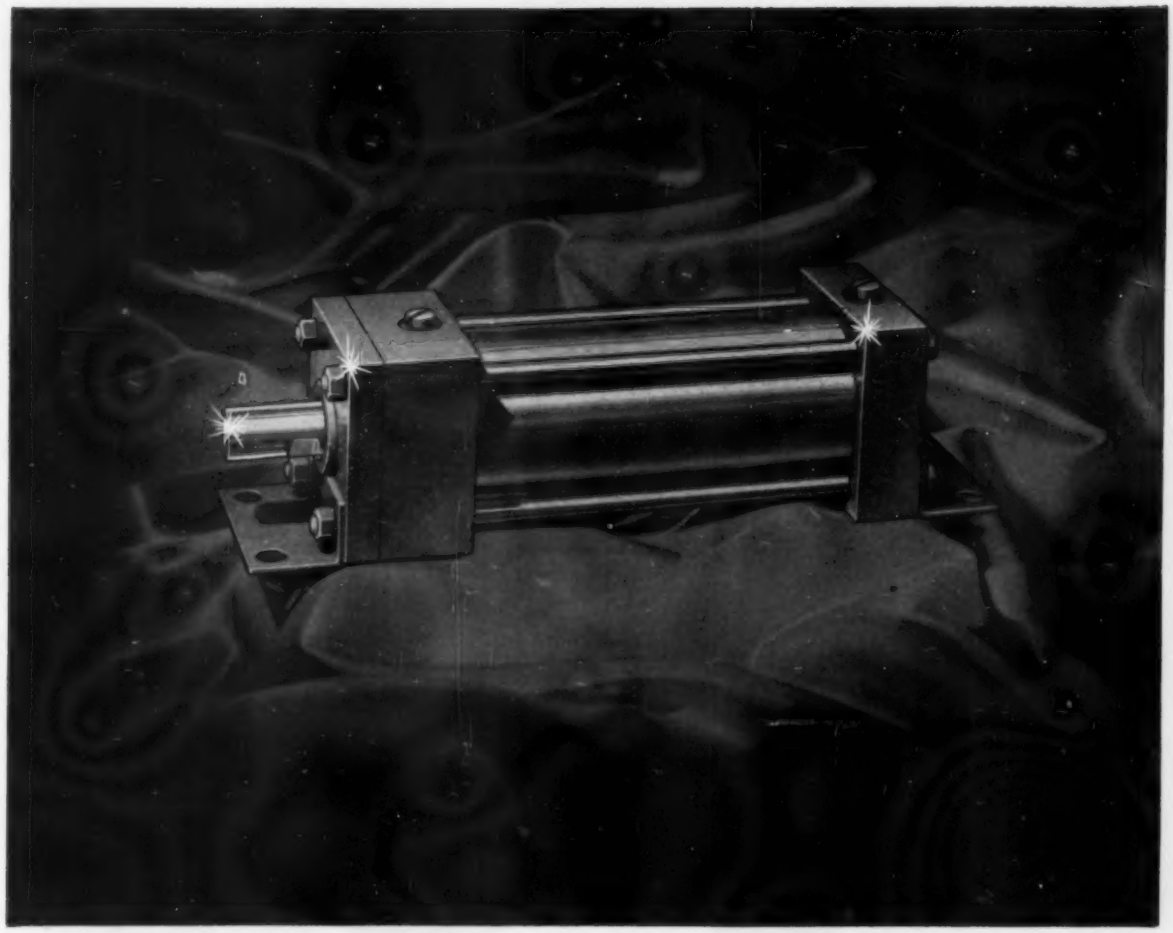
TRADE MARK

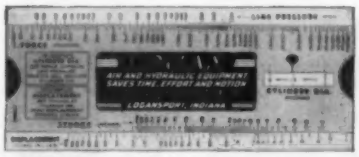
Helicoid gives you all these features at prices that are competitive in the quality gage field



Illustrated—Logansquare Cylinder Meets J.I.C. Standards

Look to Logan

the ultimate in air cylinder design



FREE SEND FOR THE "LOGAN CALCULATOR"
A gift to you from Logansport Machine Company upon request.

MEMBER: Natl. Mach. Tool Builders' Assn.; Natl. Fluid Power Assn.

LOGANSPORT MACHINE CO., INC.
832 CENTER AVENUE, LOGANSPORT, INDIANA

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- ☐ 100-1 AIR CYLINDERS
- ☐ 100-2 MILL-TYPE AIR CYLS.
- ☐ 100-3 AIR-DRAULIC CYLS.
- ☐ 100-4 AIR VALVES
- ☐ 100-5 LOGANSQUARE CYLINDERS
- ☐ 100-5-1 ULTRAMATION CYLINDERS
- ☐ 51 PRESSES
- ☐ FACTS OF LIFE
- ☐ 62 SURE-FLOW PUMPS
- ☐ 200-1 HYD. POWER UNITS
- ☐ 200-2 ROTOCAST HYD. CYLINDERS
- ☐ 200-3 750 SERIES HYD. CYLINDERS
- ☐ 200-4 and 200-7 HYD. VALVES
- ☐ 200-6 SUPER-MATIC CYLS.
- ☐ 70-1 CHUCKS
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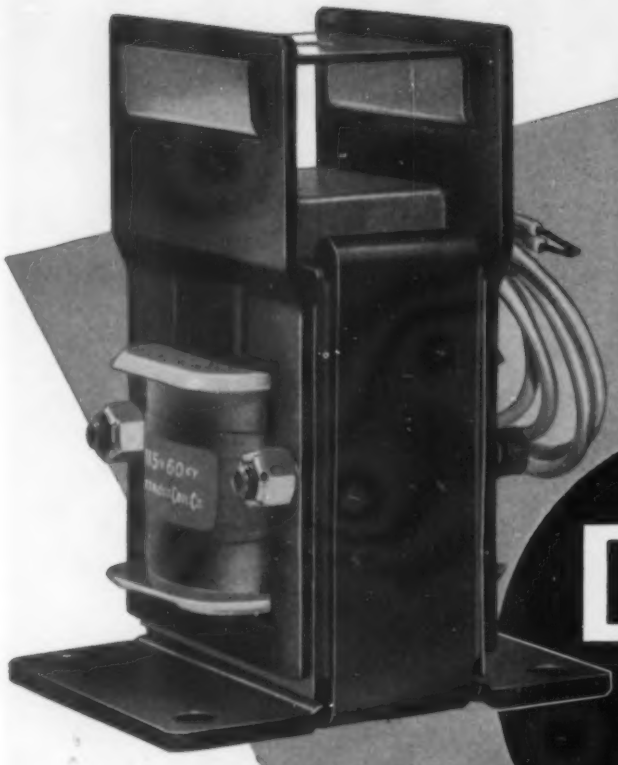

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- Decco shock-mounted for long life.
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Decco's Series 50 offers more power—longer stroke with the same dependable quality and performance that has made Decco the top name in industrial solenoids.

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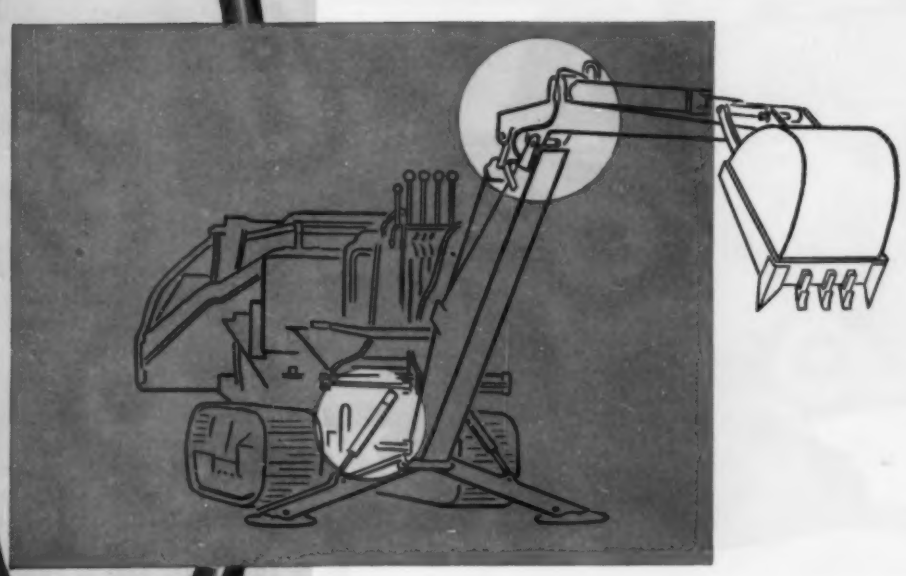
...for greater dependability...LONGER

**LINEAR KEEPS THE "BITE"
IN A BACK-HOE
with Roto-Mold "O" Rings**



The "bite" of a back-hoe—or any of the countless other small and large earth moving machines—depends on the use of precision seals that can retain hydraulic pressure in pumps, controls and actuating cylinders under all conditions. LINEAR Precision Roto-Mold "O" Rings provide the dependability that keeps expensive equipment operating longer at peak efficiencies—around the clock.

LINEAR'S extensive experience in working with all types of elastomers enables the selection of materials that can stand up under extreme temperature variations, continuous exposure to abrasive dirt and dust, and against surge pressures which may fluctuate to as much as 50,000 psi.

The exclusive Roto-Mold process makes possible precision "O" rings—physically better—free from foreign inclusions and flash. Another plus is scheduled deliveries at maximum economy.

No matter what your sealing problem may be—call on LINEAR or one of its agents for engineering assistance—and be sure to specify LINEAR Roto-Mold "O" Rings.

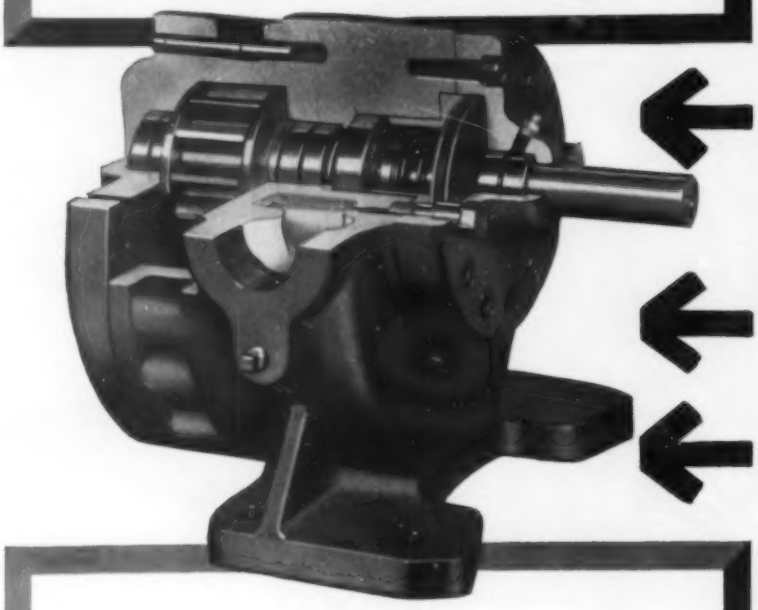
"PERFECTION IN RUBBER"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

ROPER OFFERS YOU

FLEXIBILITY



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Write today for...
"HOW TO SOLVE PUMPING PROBLEMS"

ROPER *Rotary Pumps*

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705 Blackhawk Park Avenue
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Future Events

May 16-17: Eighth Annual National Conference and Convention, American Institute of Industrial Engineers to be held Hotel Statler, New York City. Additional information from D. J. Duffy, 44 West 96th St., New York 25, N. Y.

May 20-23: ASME Second Design Conference, held in conjunction with Design Engineering Show, New York Coliseum.

June 9-13: Semi-Annual Meeting, American Society of Mechanical Engineers, Sheraton-Palace Hotel, San Francisco.

June 9-14: Third Annual Automation Seminar, Pennsylvania State University, University Park, Pa. For complete information and registration contact Chester Linsky, assistant professor of industrial engineering.

June 12-14: Operations Research Conference, Illinois Institute of Technology, University Campus, Chicago. Additional information from Conference Coordinator, Illinois Institute of Technology, 3300 S. Federal St., Chicago 16, Ill.

September 9-12: SAE Tractor Meeting and Production Forum, Hotel Schroeder, Milwaukee, Wis.

September 9-13: 12th Annual Instrument Automation Conference and Exhibit of The Instrument Society of America. Public Auditorium, Cleveland, Ohio.

October 1-5: SAE Aeronautic Meeting, Aircraft Production Forum and Aircraft Engineering Display, The Ambassador, Los Angeles, Calif.

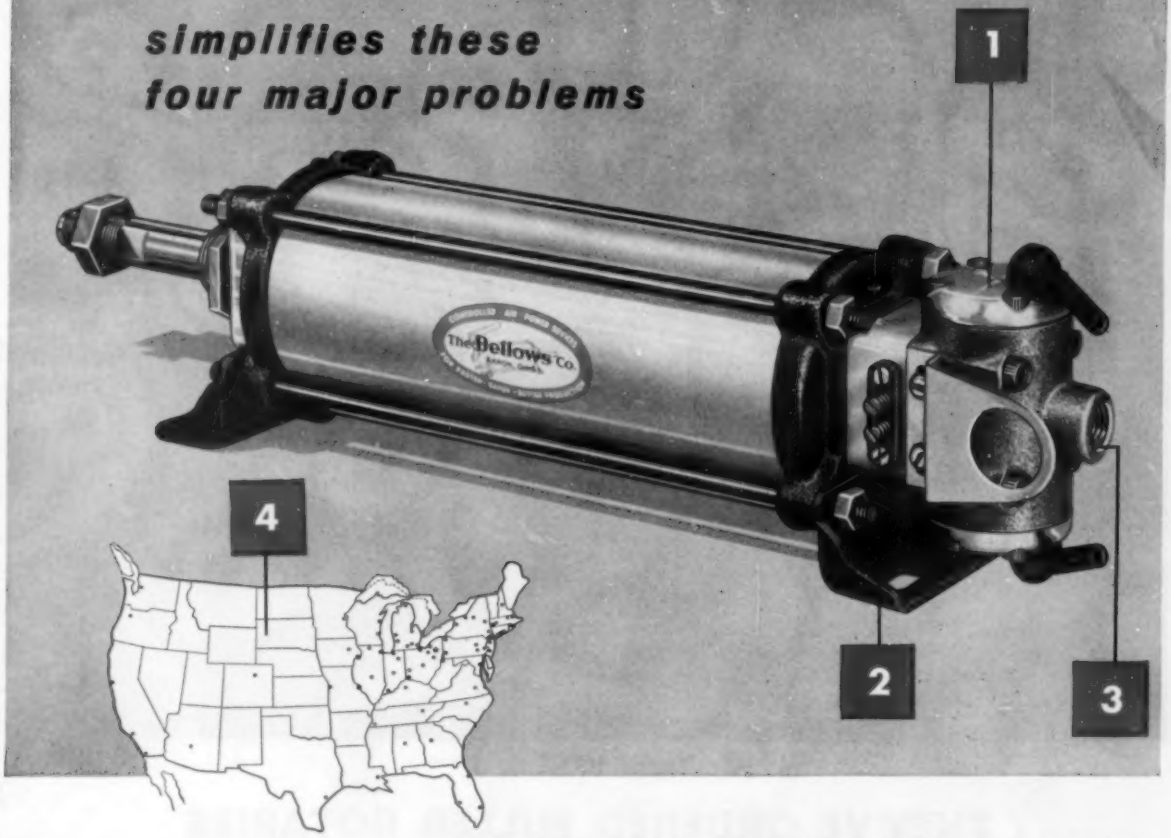
October 17-18: The 13th Annual Conference on Industrial Hydraulics. Hotel Sherman, Chicago, Illinois. Raymond D. Meade is Conference Secretary.

October 23-25: Fall meeting National Fluid Power Association, Washington, D. C. For details write: Barrett Rogers, NFPA, 1618 Orrington Ave., Evanston, Illinois. ▼▼▼

Circle 131 on Reader Service Card

THE Bellows AIR MOTOR

simplifies these four major problems



1 **Built-in electrically controlled directional valve, either 8 or 110 v., simplifies design problems.**

2 **Built-in speed controls for accurate regulation of piston rod speed simplify control problems.**

3 **The single air connection, which can be made with flexible air hose, simplifies installation problems.**

4 **More than 125 Bellows Field Engineers in the United States and Canada simplify service problems.**

Design, control, installation and service are problems every O.E.M. Design Engineer faces when selecting components for automation.

In pneumatic design, the Bellows Air Motor—the air cylinder with the built-in valve—simplifies his problems. Instead of separate valving for directional control, separate valving for speed control, multiple mounting, complex and cumbersome piping for air supply—he works with one compact, complete power unit.

Not only are design and control simplified when you specify "Bellows", but installation costs are less; and you know wherever your machine is shipped, a Bellows Field Engineer will be available for service if it is ever needed.

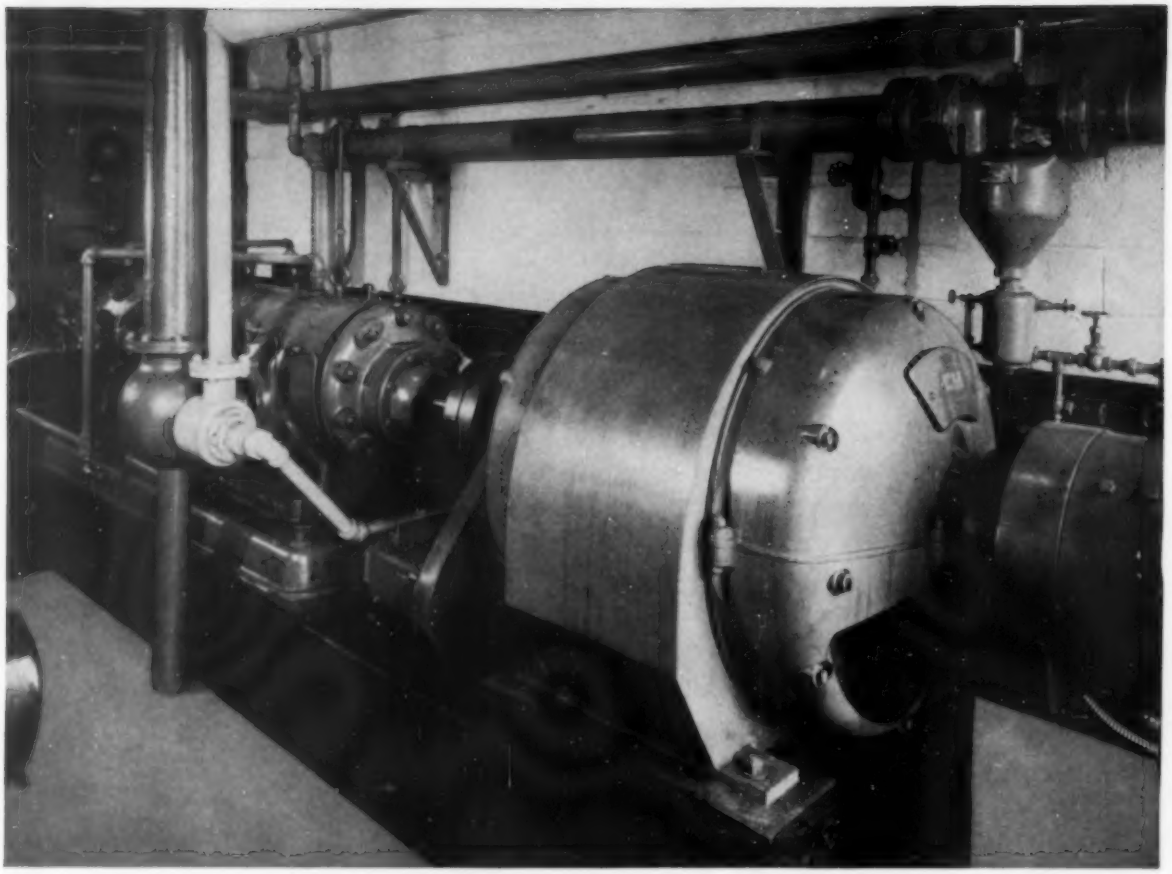
Write for Bulletin BM-25
"The Story of The Bellows Air Motor"
Address: Dept. AH-557
The Bellows Co., Akron 9, Ohio

The Bellows Co.

AKRON 9, OHIO

In Canada: Bellows Pneumatic Devices of Canada, Ltd., Toronto, Ont.

8448



THEY'VE ORDERED FULLER ROTARIES AGAIN AND AGAIN . . .

The proof is the record. Reading Tube Corporation bought its first Fuller Two-Stage Rotary Compressor in 1944—a C50-50H. To meet expanding pneumatic power requirements for increased production, they added a C100-100H Rotary in 1946. Again, the only and obvious choice was Fuller. In 1953, Reading Tube installed its third Fuller Rotary—a C175-175H, and reports continued satisfactory and economical operation, with a bare minimum of maintenance on all three.

Reading Tube Corp. uses Fuller compressors exclusively for such variety of needs as supplying air power in their casting shop, mill, draw benches, in testing and packing, as well as for hand accessories such as grinding, polishing, drilling, etc.

Check these advantages when your plant needs reliable air power . . . . they've made Fuller the choice, time and time again.

- . . . full capacity for life of the machine
- . . . smooth air flow
- . . . sustained performance for top capacities up to 3300 c.f.m. and pressures to 125 pounds
- . . . compactness and ease of installation, requires minimum space and light foundation
- . . . vibrationless due to absence of reciprocating parts.

To get all the facts, write today for Bulletin C-5A.

C-310
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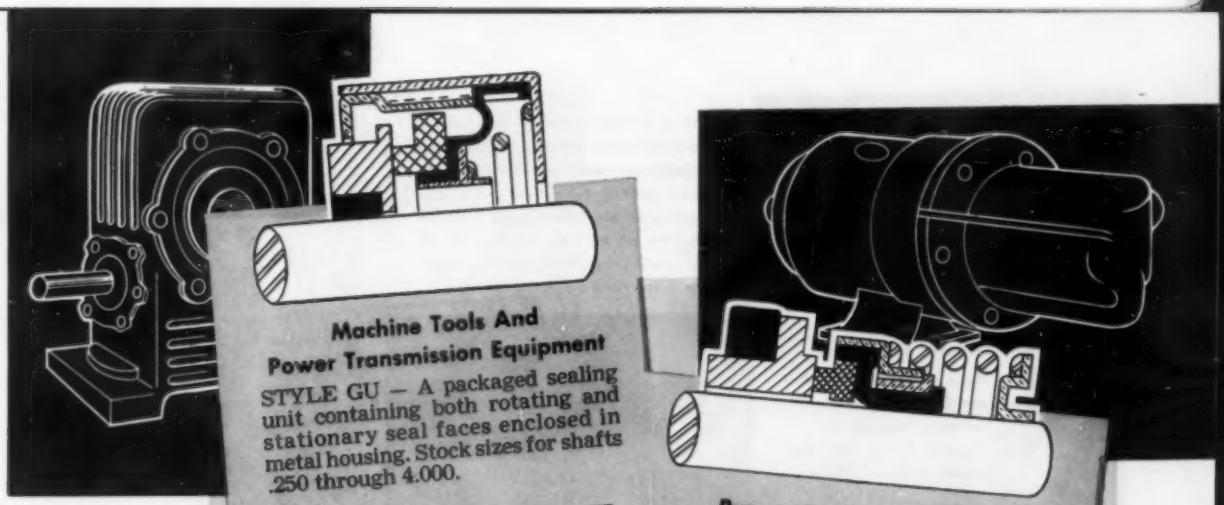
Fuller

PIONEERS OF HIGH-EFFICIENCY VANE TYPE ROTARY COMPRESSORS SINCE 1930

Circle 54 on Reader Service Card

Circle 61 →



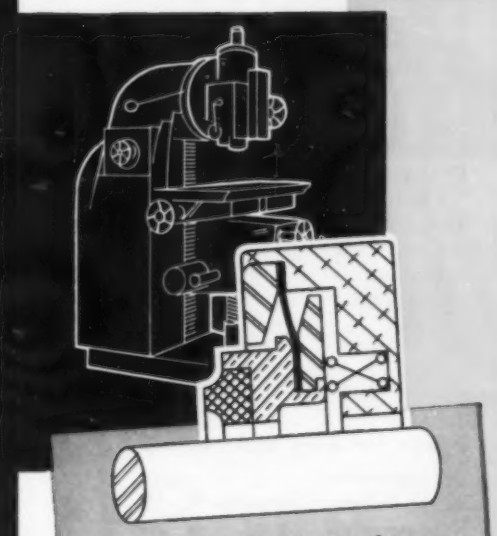
Machine Tools And Power Transmission Equipment

STYLE GU — A packaged sealing unit containing both rotating and stationary seal faces enclosed in metal housing. Stock sizes for shafts .250 through 4.000.

Pumps And Compressors

ROTO-FLEX — Rugged flexibility. Only 3 parts. Single or double units. Stock sizes for shafts .250 through 4.000.

STYLE RFO — A specially designed Roto-flex seal, for installation outside the stuffing box. Stock sizes for shafts .250 through 4.000.



Heavy Machine Tools

STYLE DPC — A high-speed, carbon-faced seal, for more compact installation in heavy industrial machinery. Stock sizes for shafts .250 through 4.000.

A Complete Line GITS SHAFT SEALS For Every Application

These modern, mechanical, face-type seals are carried in stock — to save you time and money. Write for detailed data.

GITS BROS. MFG. CO.

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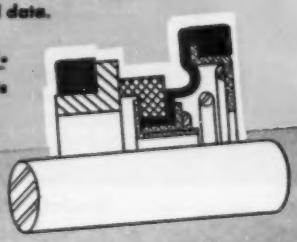
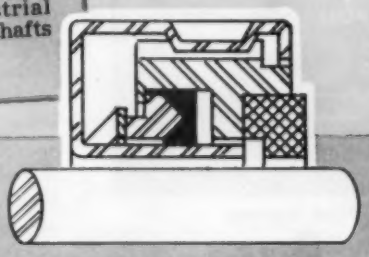
Specialists In Lubricating Devices And Shaft Seals For Almost Half-A-Century



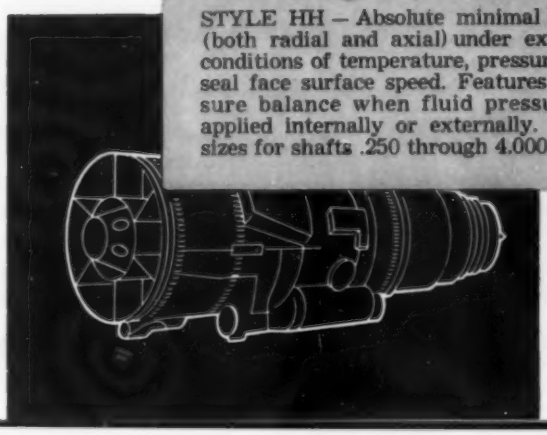
Household Appliances

STYLE SGU—A factory-assembled unit-type seal for the small-budget user. Stock sizes for shafts .250 through 1.000.



Aircraft Engines And Accessories

STYLE HH — Absolute minimal space (both radial and axial) under extreme conditions of temperature, pressure and seal face surface speed. Features pressure balance when fluid pressure is applied internally or externally. Stock sizes for shafts .250 through 4.000.



Ledeen VALVES for longer life

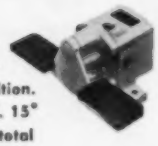
Ledeen Valves are built to operate single or double acting pneumatic and hydraulic cylinders, and motors. These valves embody the rotating disc construction to give the longest possible life. They are built in sizes from ¼" to 1¼" standard pipe connections. Available from stock for quick delivery.

Model HMN
Hand operated to Forward and Reverse. Manual Return to Neutral. 30° throw each way. 60° total throw. Rated at 250 psi.

Model HSN
Hand operated to Forward and Reverse. Spring Return to Neutral. 30° throw each way. 60° total throw. Rated at 100 psi.

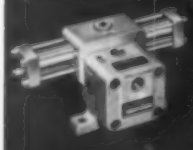
Model HSR
Hand operated to Forward. Spring Return to Reverse. No stop in Neutral position. 60° total throw. Rated at 100 psi.

Model FFN
Foot operated to Forward and Reverse by depressing proper pedal to extreme position. Foot Return to Neutral. 15° throw each way. 30° total throw. Rated at 250 psi.

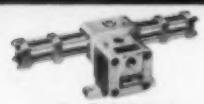


Model FSN
Foot operated to Forward and Reverse by depressing proper pedal to extreme position. Spring Return to Neutral. 15° throw each way. 30° total throw. Rated at 100 psi.

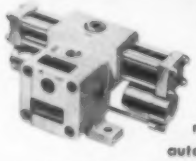
Model FSR
Foot operated to Forward. Spring Return to Reverse. No stop in Neutral position. 30° total throw. Rated at 100 psi.



Model POR
Power operated to Forward or Reverse. No Neutral position. Total throw 60°. Rated at 250 psi.

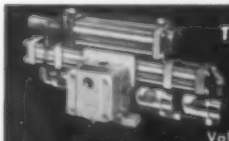


Model PON
Power operated to Neutral, Forward and Reverse. Total throw 60°. Rated at 250 psi.



Model POR
SOLENOID OPERATED 2-position, Power Valve for remote control or automatic operation. Momentary or continuous energizing.

Model PON
SOLENOID OPERATED 3-position Power Valve for remote control or automatic operation. Momentary or continuous energizing.



Time Delay Valve
Pneumatic Time Delay Valve. Adjustable from 2 seconds to 2 minutes. Available in POR and PON Models.

Pilot Valves

3-way Finger, Cam, Air and Solenoid operated models available in Normally Open and Normally Closed types.

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VALVES • CYLINDERS • VALVE ACTUATORS
AIR-HYDRAULIC PUMPS AND BOOSTERS

LETTERS to the editor

Address your letters to: Editor, APPLIED HYDRAULICS Magazine, 812 Huron Rd., Cleveland 15, Ohio.

Hydrostatic Transmissions

I have read Mr. McNeil's article in the March issue with a great deal of interest. In my earlier days in automotive design I knew of three companies that tried hydrostatic design in cars and trucks.

I think only a few engineers know the power requirements of fluids under pressure: 1 gpm at 1000 psi equals .583 hp.

Figure out flow per minute, volume, pipe sizes, weight, and cooling, and the answer is evident for lightweight vehicles. Heavy duty road machinery might be okay.

GEORGE S. CROSS
Detroit, Mich.

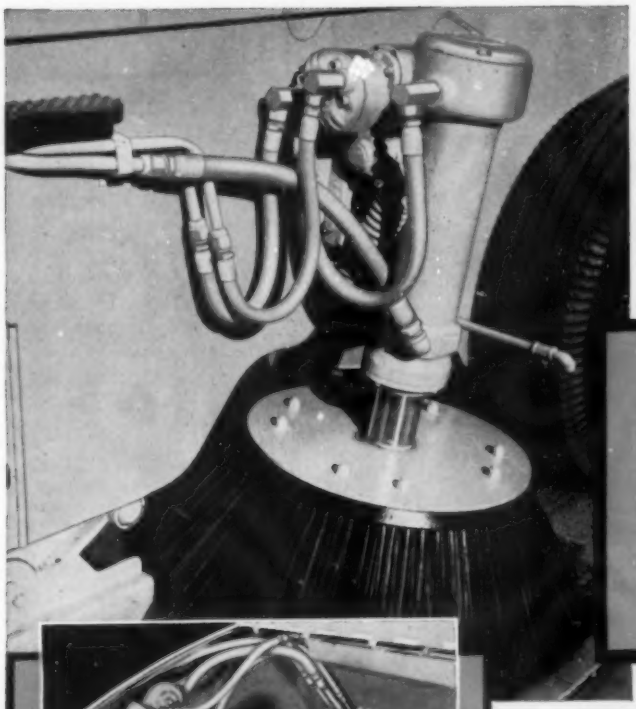
Design for Easy Maintenance

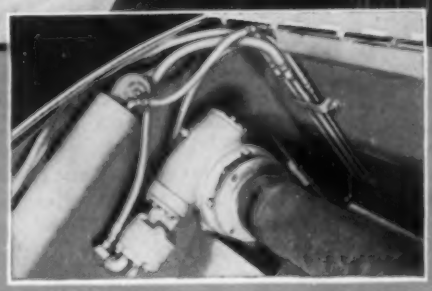
I read with interest, the article in the February issue by B. M. Dunham on "Effect of Sludge on Hydraulic Oil", and also several previous articles on the same subject. The following viewpoint might be of interest to some readers.

The chief obstacle a maintenance man encounters is the absence of properly located drain points, necessitating in many cases, re-piping and other alteration. A little forethought in the original design would overcome this obvious fault.

A few other points come to mind: Tubing and pipe installations, used on a framework that is flexible as on most mobile equipment, should be terminated with short lengths of hose. Jacks and cylinders designed with internally threaded ends of the same dimensions as the cylinder and/or having the openings for admission of fluid drilled directly into the side wall of the cylinder, constitute a

Continued on page 22





Two hydraulic circuits are used at maximum pressure of 1250 psi., supplied by direct driven pumps independent of vehicle drive.

Conveyor belt is driven hydraulically. Main broom floats under hydraulic pressure, with one lever controlling broom rotation, activating automatic belt training and conveyor belt rotation. Double acting hydraulic cylinders also open and close hopper.

THREE HYDRAULIC CONTROLS INCREASE BROOM LIFE:

1. Constant sweeping pressure maintained hydraulically with "floating" pressure, which compensates for any street irregularities.
2. Relief valve protects mechanism from curb damage.
3. Snubbing action eliminates bounce and undue wear to the broom.

HYDRAULICS IMPROVE SWEEPER PERFORMANCE

Eastman—Elgin Engineering Staff Cooperate to Improve Efficiency and Service . . . Cut Manufacturing Costs

When Elgin Sweepers were converted to hydraulics, Elgin engineers enlisted the cooperation of Eastman engineers in the pilot application of Eastman Hydraulic Hose Assemblies.

The result of Elgin's conversion to hydraulics was more than an improvement in operating performance and efficiency—it resulted in space-saving economies which permitted dramatic improvements in streamlined design—as well as reduced manufacturing and maintenance costs.

Again, as in many instances in the past . . . Elgin, who pioneered the first successfully marketed sweeper in 1912 . . . turned to Eastman—who pioneered in the very first applications of Hydraulic Hose Assemblies. LEACH PACKMASTER, an associate Elgin product, is also an original Eastman user.

We invite you to write if you have a hydraulic conversion problem. We urge you to call upon our more than 40 years of experience—unequalled in the industry. Take advantage of our many original designs and advanced construction features. Enjoy the sales prestige of Eastman Hydraulic Hose Assemblies—*Standard of the Industry!*

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first in the field

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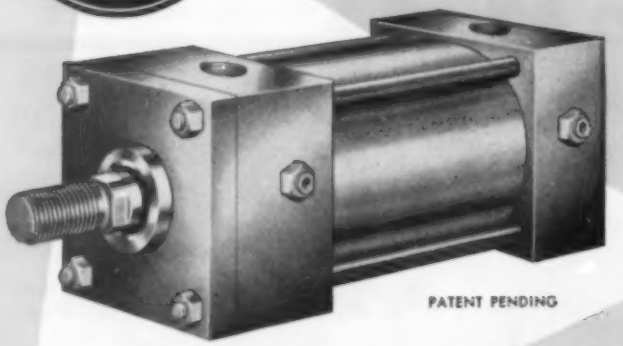
FOR AUTOMATION

SP CYLINDERS



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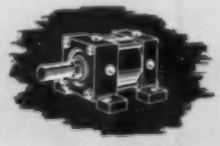
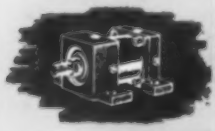
top performance–longest life

All S-P cylinders are engineered throughout for high speed, efficient operation. Piston rods are heat treated and hard chrome plated to resist scoring. Bronze cartridges with extra long bearing surfaces are easily removable for quick servicing of rod seals and wipers. End plates are rolled steel. All S-P cylinders are built to JIC standards.

S-P STANDARD AIR CYLINDERS have brass tubes to eliminate corrosion. Cushions float on O-rings for maximum cushioning. Eleven bore sizes, 1½" — 14". 21 mounting types. Readily modified for oil or water. Send for Catalog No. 110.

S-P HEAVY DUTY AIR CYLINDERS for automation and other severe applications. Double porting for extreme high speeds. Heavy wall seamless steel tube. Nine bore sizes, 1½" — 8". Five mounting types. Approved and used by two major automobile manufacturers. Send for Catalog No. 109-A.





S-P HIGH PRESSURE HYDRAULIC CYLINDERS have seamless steel tube. Special locking mechanism eliminates tie rods. Designed for 2,000 psi. Eleven models in 11 sizes. Send for Catalog No. 104.

Step up production with S-P cylinders. Representatives in principal cities. Prompt deliveries. Order catalog by number shown above. The S-P Manufacturing Corporation, 30201 Aurora Rd., Solon, Ohio. *In greater Cleveland.*

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ESTABLISHED 1916 A BASSETT COMPANY

NON ROTATING AIR AND HYDRAULIC CYLINDERS • ROTATING AIR AND HYDRAULIC CYLINDERS POWER CHUCKS • COLLET AND DRILL PRESS CHUCKS • AIR PISTONS, VALVES, ACCESSORIES

LETTERS to the editor

maintenance headache when replacement of packings other than metal rings becomes necessary.

I feel certain that these and other annoying incidentals will eventually be overcome, but to us maintenance people, operating some of the earlier models, it means redesign or repeating the same encounter at each service period.

A. F. LEVITRE
Mobile Equip. Machinist
City of Seattle
Department of Lighting

Hydraulic Course

I am a foreign engineer, here for one year of specialized studies. One of my main interests is high pressure oil hydraulics. I planned to take a summer course at MIT, called Fluid Power Control. Unfortunately this course is not given this year. Do you know about a similar course offered anywhere in this country?

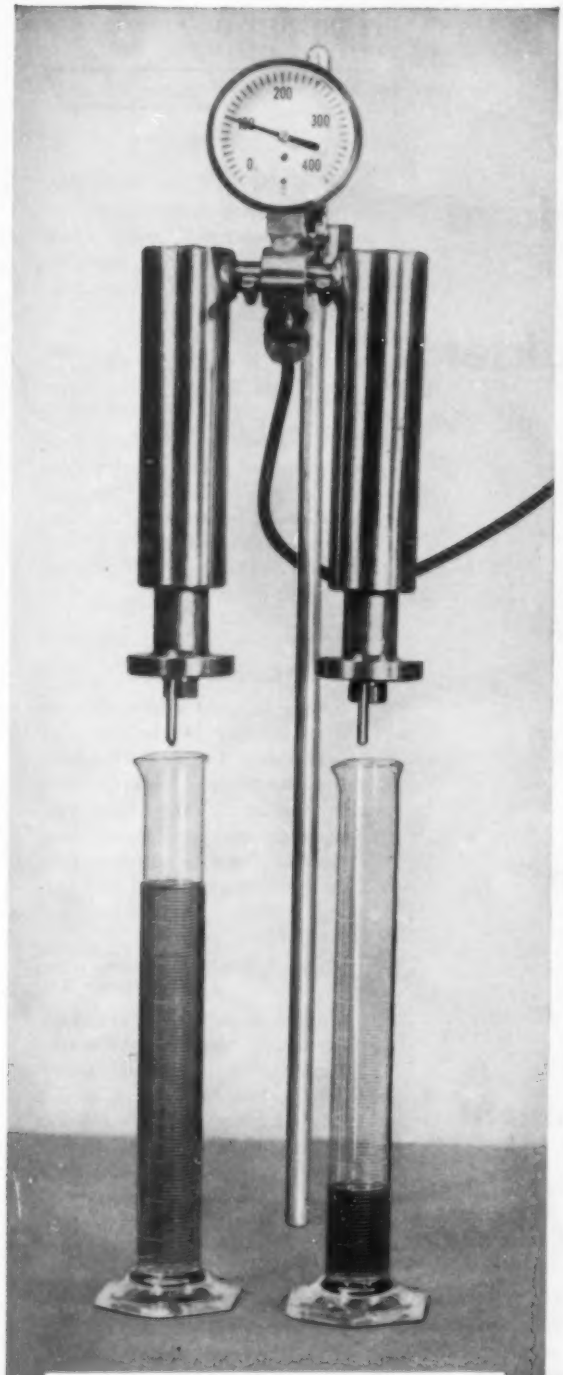
AKE PERSSON,
Brooklyn, N. Y.

There is no comparable course to the one offered by MIT, which requires a good background in mathematics. However, Illinois Institute of Technology has a two-week course set up for this summer, aimed toward the practical application of hydraulics. You can write to Raymond D. Meade, Conference Secretary, National Conference on Industrial Hydraulics, Technology Center, 3300 S. Federal St., Chicago 16, Illinois, for complete information.

Tube Finishing Tool

Could you help us with some information? We have enclosed drafts of a tool for finishing seamless tubes to a high degree of finish by means of rollers which travel on the cone. We have seen this tool used by some other company, but it was a "home-made" copy of an American tool, and the fellows did not remember the

Continued on page 24



Less oil loss with Suntac is proved by this leakage demonstrator. Suntac oil is placed in one chamber, a straight mineral oil of the same viscosity in the other. Both oils are pressured through sintered bronze bearings. At 100 psi the straight mineral oil leaks out four times faster than Suntac.

LEAKAGE DEMONSTRATOR PROVES SUNTAC CAN CUT OIL LOSS AS MUCH AS 75%

Expensive equipment overhauls to stop leaks in hydraulic systems can often be avoided by a change to Suntac®. The exceptional antileak characteristics of Suntac oils can reduce oil losses as much as 75%, as can be proved in the leakage demonstrator. *Some users have reported actual drops in oil leakage of 90%.*

Suntac oils give you lower lubrication costs, cleaner equipment and floors, safer working conditions. Their leak-reducing agent leaves no gummy film or residue. In addition, Suntac oils are fortified against oxidation to lengthen oil life...against rust and corrosion to lengthen equipment life.

You'll find Suntac a money and time saver in your hydraulic systems...and a high-quality general-purpose oil for many other uses.

WANT MORE SUNTAC FACTS? Ask your Sun representative for Technical Bulletin 23. Or you can get full details, prices, and delivery information by writing to SUN OIL COMPANY, Philadelphia 3, Pa., Dept. **AH-5.**

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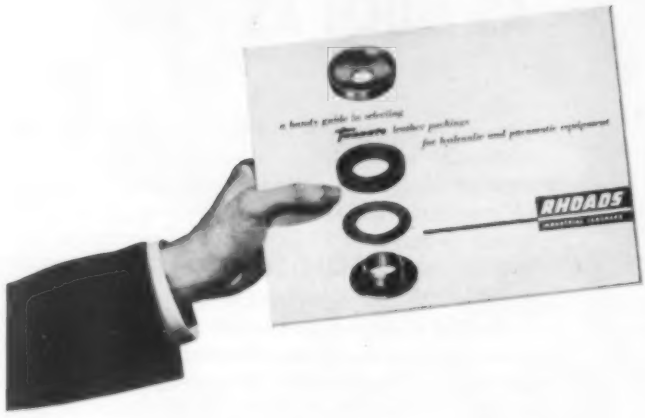
Specifying Packings? You Should Have This Free Technical Booklet



a handy guide in selecting leather packings for hydraulic and pneumatic equipment

This colorfully illustrated, clearly written eight page booklet tells you just where to use and how to select U, Vee, Cup or Flange Packings for hydraulic and pneumatic applications. J.I.C. sizes, standard nomenclature, dimensions, etc. enable you to specify Packings quickly, easily and economically. Write on your business letterhead, to

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RHOADS
INDUSTRIAL LEATHERS

LETTERS to the editor

name of the original fabricator. So, instead of manufacturing it on our own, we would rather know the name of the U. S. manufacturer and order if from him. Could you find it?

E. AUBERT
Manager
Compagnie Francaise D'Organisation
Paris, France

On a recent trip to Detroit we learned about a tool which we believe is the one you are looking for. Copy of your letter and drawings have been sent to Hole Engineering Service, Detroit, Mich. They will contact you.

Circuit Guide

Kindly forward information on the availability of the booklet "Fluid Power Circuits". We have had a few of these booklets available to us in our sales engineering department and have found them extremely useful in customer contacts and the training of new personnel.

HAROLD E. WAHLSTROM
Racine Hydraulics & Machinery, Inc.
Racine, Wis.

This booklet was originally published in January, 1954. Because of the great demand, we revised this booklet and published it in the January 1957 issue under the title of "Air & Oil Circuit Guide". Reprints are available, priced at 50 cents per copy in quantities less than 100, and 35 cents per copy in quantities of 100 or more.

Annual Index

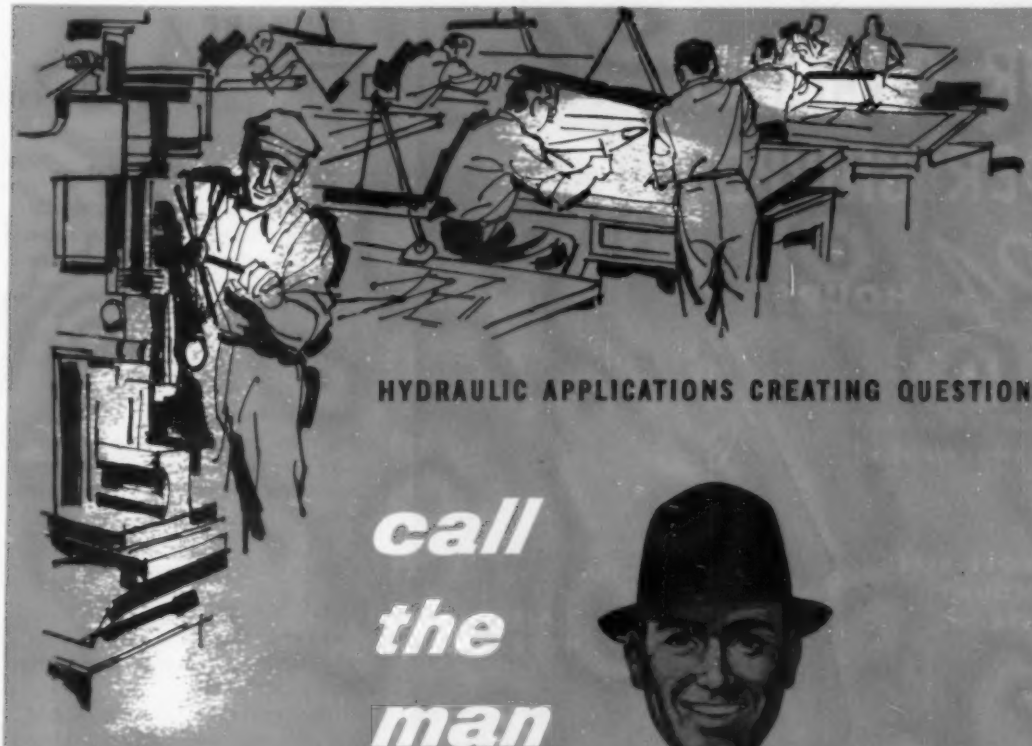
Inadvertently, I let the December issue slip from me before I had clipped the annual index. I would appreciate it if you would send a copy to me.

ERIC JENNETT
Process Engineer
Brown & Root, Inc.
Houston, Texas

Copy of the index has been sent.

Continued on page 26

Circle 129 on Reader Service Card



HYDRAULIC APPLICATIONS CREATING QUESTIONS?

call the man from Webster

Evaluating hydraulic systems? Balancing pressures and flows against costs? Then, the man from Webster can help you. Today, when you are caught between price and performance, his technical help slanted in a fresh direction, can be the push that gets you into the clear. Call the man from Webster whenever you require hydraulic pump help for lubricating, oil circulating, filtering, transfer or quiet hydraulic power applications. He's a good man to have on your design team.

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MELROSE 3-3511
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OVER 100 MODELS

Capacities: *1/5 to 30 GPM*
Pressures: *Up to 1500 PSI*
Speeds: *Up to 3600 RPM*
Drives: *Direct or Geared*
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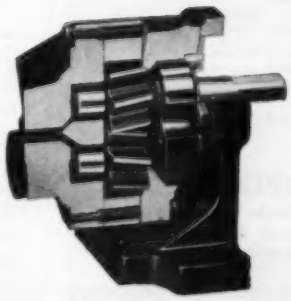

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- Please send the following -

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ROTARY ACTUATORS • SPECIAL CONTROLS

LETTERS to the editor

Pneumatic Poppet Valves

On page 57 in the Beginner's Course In Basic Pneumatics, I got a little confused with the Figure 64 showing the normally closed valve. Aren't the two valve drawings transposed?

Another question is: When the stem is pressed down slowly, as happens when operated by a rotating cam, then the inlet opens before the exhaust side closes. Are there any valves on the market without this disadvantage?

KURT STOLL
Port Washington, N.Y.

You are quite right about the valve drawings. The normally open and normally closed valves are transposed.

Cam operation is not applied to the double faced poppet valves shown in the drawings. Cam operated valves are designed to permit gradual action and no loss of air. In the case of solenoid or air operation of the double faced poppet valves, operation is very rapid and poppet travel is often less than 1/16 *in.*

Deceleration Problem

We are facing the deceleration problem of a large inertia mass. A hydraulic motor is used for the drive. To decelerate the rotating mass and the hydraulic motor quickly, and without shocks, we need a decelerating valve of about 6 gpm capacity. We would appreciate your recommendation of manufacturers of these valves.

D. Z. DVORAK,
Supervisor
Product Research & Development
Standard-Modern Tool Co. Ltd.
Toronto, Ontario,
Canada

There are a number of manufacturers of hydraulic valves who could supply a cam-operated, deceleration valve having that rating. However, as you probably know, the valve in itself may not be the solution to your deceleration problem. We have given you the names of several manufacturers. ▼▼▼

Circle 30 on Reader Service Card

Circle 57 ⟶

MORE OF THE GARLOCK **2,000**

Special Braiding Machines produce Garlock LATTICE-BRAID Packings. Designed and built for Garlock, these machines produce a pattern which cannot be made on ordinary braiders.

HOW GARLOCK LATTICE-BRAID* PACKINGS DIFFER

from Ordinary Braided Packing

Chemical Industry

Centrifugal dye pumps required repacking every 24 to 48 hours. Changed to LATTICE-BRAID asbestos packing with Teflon impregnation. Results: minimum of 3 months' service.

The Garlock LATTICE-BRAID Packing is distinctly different . . . the result of many years of development and experimental work.

Special machines are required to manufacture the LATTICE-BRAID structure. And the superiority of LATTICE-BRAID packings is due to the unique braiding pattern which cannot be duplicated on ordinary braiding machines.

ADVANTAGES: unified structure gives greater strength; no disintegration; less gland adjustment; unusual flexibility.

LATTICE-BRAID is another important part of "the Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals to meet all your needs—the *only* complete line. That's why you get *unbiased* recommendations from your Garlock representative. Call him today or write for LATTICE-BRAID Folder AD-131.

THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

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GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

IMPERIAL HI-SEAL

the flareless tube fitting that makes a positive butt-joint

The most important advance in tube fittings in 20 years!

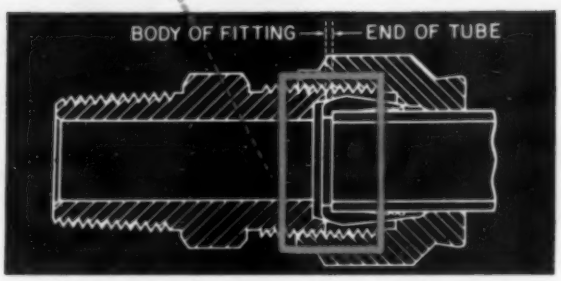
No need to spring tubing • withstands high pressures
foolproof assembly • no flaring or threading

Checks on typical high-pressure tubing jobs show you can cut installation time substantially with Hi-Seal fittings . . . *save up to 53% compared with flare-type fittings.* Hi-Seal completely revolutionizes high-pressure tubing installations!

Foolproof assembly! Pressure-tight joints and re-connections can be made even by the inexperienced. There's only *one* way tubing can be inserted into sleeve . . . only *one* way sleeve goes into fitting.

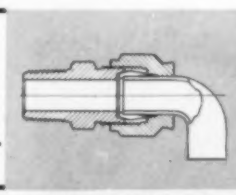
Positive butt-joint! No tube entry into body of fitting. No springing of tube. Especially important with large-diameter, heavy-wall, hard-temper tubing, or short lengths of tubing.

Closer tube bends! Butt-joint and no-flaring features mean bends can be made exceptionally close to end of tubing. Hi-Seal fittings work in close quarters where other types of fittings cannot be used!



See above **how tube "bottoms" on shoulder of sleeve. Camming action of nut causes sleeve to form a collet-type triple-seal grip on tubing. Final circumferential seal is made by tapered edge of sleeve. No tube torquing when making a joint.**

MEETS J.I.C. AND A.S.M.E. STANDARDS LISTED BY U.L.



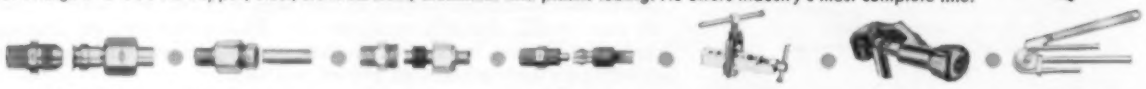
Permits Closer Tube Bends Than Any Other Fittings!

Hi-Seal fittings are furnished in steel and stainless steel — for ⅛ to 1½" O.D. tubing.

Write for Bulletin 3061 and complete facts.

SEE YOUR IMPERIAL DISTRIBUTOR:

for fittings and tools for copper, steel, stainless steel, aluminum and plastic tubing. He offers industry's most complete line.



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WELL, WHAT DO YOU KNOW.... DRY!

Unusual in a hydraulic system, perhaps, but not impossible. And there is no need to limit operating pressures to 1000 p.s.i. in order to obtain, or approach "dry" performance.

The answer is to be found in the design and construction of the components of a system as well as the circuit layout itself. The right thing to do is to *eliminate* leakage from the start, not to control it when it occurs.

Over the years we have taken pride in the fact that our hydraulic systems provide leakproof performance regardless of operating pressure or duty cycle. It's another case in point where quality equipment . . . and engineering . . . mean quality performance.

So don't accept fluid leakage as a necessary evil . . . let us show you the many advantages of Lassman equipment and how it can provide you the ultimate in reliable operation.

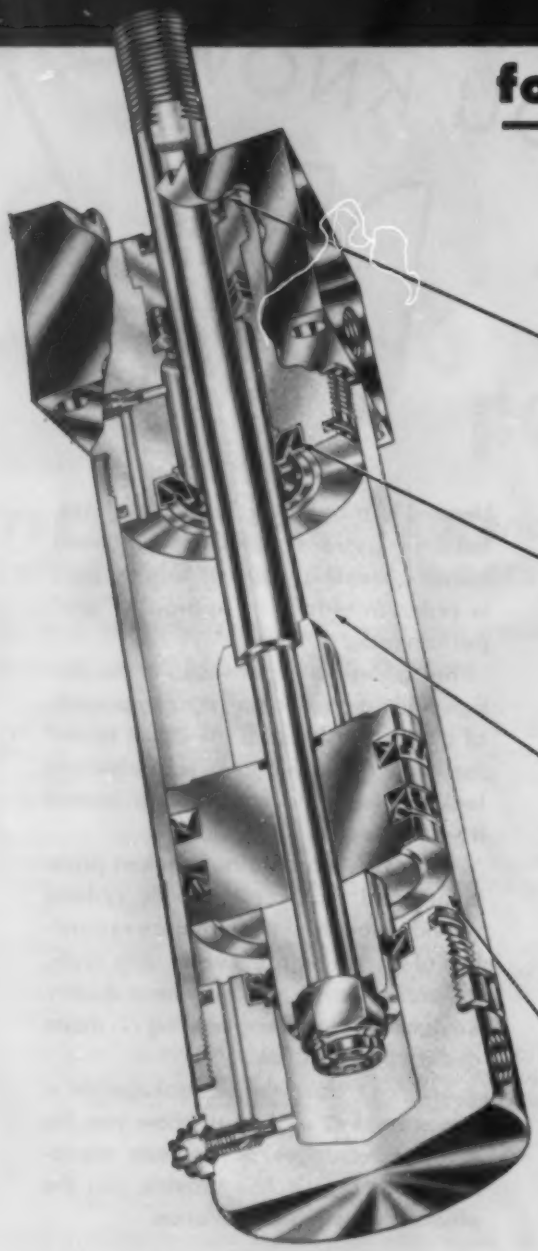
Quality EQUIPMENT for *Quality* PERFORMANCE

BENJAMIN LASSMAN & SON — Route 8, GLENSHAW, PA.

Need a cylinder today?

for all these Extras . . .

T-J Spacemaker



PISTON ROD SCRAPER . . . Not just a felt or fabric wiper, but a metal to metal contact. Protects rod packing and cylinder bores at all times by actually removing foreign particles from piston rod surface. STANDARD AT NO EXTRA COST!

NEW "SUPER" CUSHION FOR AIR . . . Of T-J design and patent, it assures millions of trouble-free cycles. Years of T-J research and test have answered the problem of "how to make a cushion last". All T-J cushions are adjustable, STANDARD AT NO EXTRA COST!

CHROME PLATED CYLINDER BORES AND PISTON RODS . . . The piston rod, of course. But of these two features, the chrome plated bore is by far the most important, due to the much greater area that is subject to wear. Chrome plating of bore gives extra protection where needed most. Also a protection from condensation and foreign matter, that may find itself into the system. STANDARD AT NO EXTRA COST!

ONE PIECE PISTON . . . Giving you three point surface bearing which increases the distance from the piston end to the rod bearing. This T-J feature assures better alignment, longer bearing and packing life. STANDARD AT NO EXTRA COST!

off shelf delivery

. . . Just call T-J

at no Extra Cost!

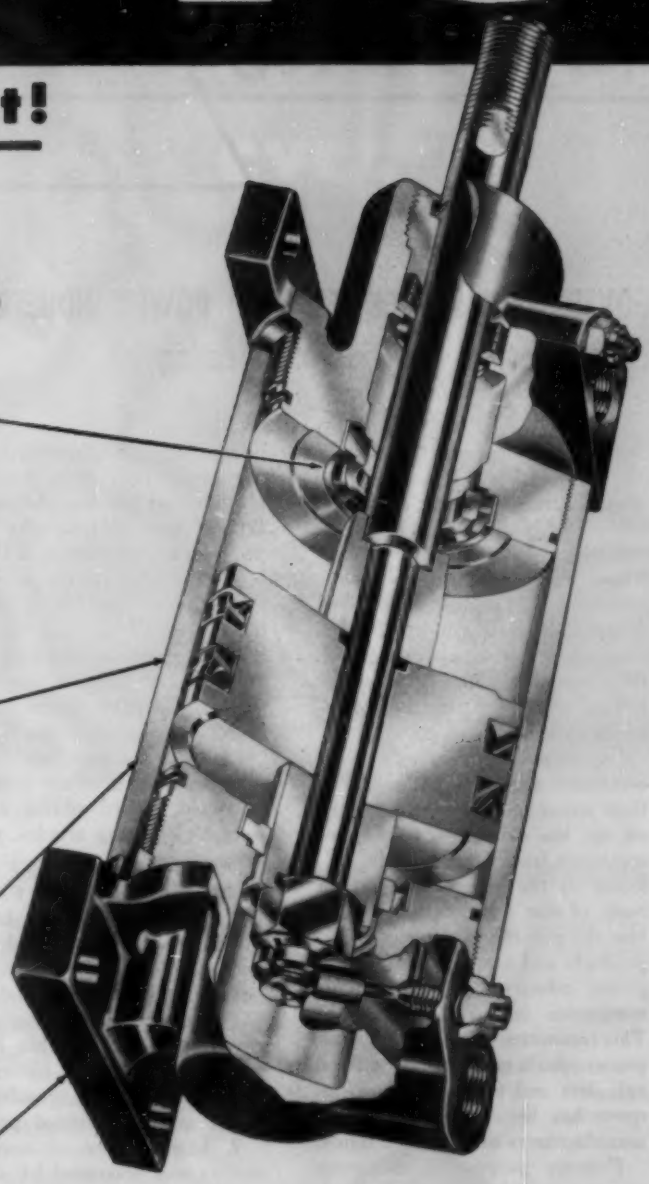
cylinders

NEW "SELF-ALIGNING" MASTER CUSHION FOR HYDRAULIC USE . . . (Pat. Applied For) New T-J cushion design eliminates problems of worn out, or out-of-line cushion seals. Eliminates need of a ball check while greatly increasing the return flow, assuring fast breakaway on return stroke. All T-J cushions are adjustable, STANDARD AT NO EXTRA COST!

NO TIE RODS TO STRETCH . . . By eliminating tie rods, the T-J SPACEMAKER gives you 360 degree port rotation, streamlined design, no tie rod stretch, without sacrificing strength. STANDARD AT NO EXTRA COST!

STREAMLINED DESIGN . . . Minimum center-line to center-line mounting—years ahead and in keeping with modern trends. Easy to clean for an extra appearance on your machine, without sacrificing strength. Oil pressure to 750 P. S. I.—air to 200 P. S. I. STANDARD AT NO EXTRA COST!

FORGED SOLID STEEL HEADS . . . (4" bore through 8" bore) Requires no additional mounting brackets, because mounting holes are a part of the one piece solid forged steel head. Its design lends itself to smooth streamlined modern appearance. STANDARD AT NO EXTRA COST!



WRITE TODAY for new bulletin with complete details of the T-J Spacemaker line, or call Jackson, Michigan, State 2-0462.

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THE TOMKINS-JOHNSON CO.

JACKSON, MICHIGAN

RIVITORS . . . AIR AND HYDRAULIC CYLINDERS . . . REAMERS . . . CUTTERS . . . CLINCHORS

Circle 152 on Reader Service Card

BRIEFS about fluid power

GOVERNMENT RECOGNIZES FLUID POWER INDUSTRY . . . report of NFPA Spring Meeting

Newest development reported at the National Fluid Power Association's spring meeting, held in Hollywood, Florida, is the formation by the government of a Fluid Power Industry Advisory Committee. David Fromson, Greer Hydraulics, is chairman of NFPA's government relations committee. He reported on the activity of the FPIAC which held its first meeting in December.

Importance of this advisory committee is the recognition of a fluid power industry. As presently set up, the committee has representatives from 16 companies, selected by the government on the basis of size and location, to advise the government on the needs, products and services of the fluid power industry. Twelve of the 16 companies are NFPA members. This committee only includes companies which make pumps, valves, cylinders and test equipment. Request has been made to include manufacturers of hydraulic fluids.

Primary purpose of this committee is to advise on realistic allocation of materials for the fluid power industry in the event of a national emergency. The committee also serves in an advisory capacity on manpower problems, industry and government standards and mobilization planning for fluid power.

• **Education**—One important function of NFPA is carried out by their education committee. Jack Ellis, Hanna Engineering's chief engineer, heads this committee. He reported the completion of a Fluid Power Bibliography which provides a cross-section of the best books available on the subject of fluid power. This bibliography is offered in a loose leaf binder so that additions can be easily made. It presently includes more than 200 subject titles. Price per copy to NFPA members is $1.75, $2.25 per copy to non-members.

Further work of the committee is aimed toward adding a bibliography covering articles, papers, transactions, etc.

• **Marketing Report**—Oliver G. Lear, Fluid Controls, Inc., reported on a work carried out to define channels of distribution, survey sales territories and stocking practices. Bulletin No. 46 was given to members. This bulletin tabulates answers by member companies concerning sales territories and stocking of products.

A brief survey of marketing outlets was presented by APPLIED HYDRAULICS' editor, Paul Rolnick. A panel then discussed the relationship between the manufacturer and distributor.

• **National Industrial Council**—Guest speaker at this meeting was R. T. Compton, executive director of NIC, who presented "Washington Observations". NIC is an organization of about 400 members. These members are manufacturers associations. His talk covered proposed legislation which could affect labor relations, pension and welfare funds, state right-to-work laws, hours and safety.

What's the atmosphere in Washington? Compton says present House of Representatives has 263 conservatives, 171 members are considered pro-union. Odds against a Republican gain in the House in the 1958 elections are 21 to 5.

• **Proprietary Rights**—This was the subject of a talk given by D. H. Siver, Watertown Division, The New York Air Brake Company. Manufacturers doing business with the government are greatly concerned about the type and amount of information required when making a proposal. Concern is with the disclosure of proprietary information.

• **Technical Board**—Walter Kudlaty, Miller Fluid Power, introduced representatives of IBM and Rem Rand, who discussed the methods of establishing a product code system which could be easily handled by available data processing equipment. The board is investigating ratings and coding.

Here, briefly, is the status of projects being undertaken by the technical board.

• **Terminology**—Collation form requires minor supplementary revision. Revisions will be made before the coming Fall Meeting so compilation of supplementary glossary material and revisions of present glossary can proceed.

• **Symbols**—Each member company has received a copy of the Symbols Standards prepared by the ASA Y32 Committee. The

Continued on page 34

PUMPS FUMING NITRIC ACID

14.7 MILLION CYCLES

...AND THE HEART OF THIS VANTON PUMP IS C/R SIRVENE

Vanton Pump engineers knew what they wanted—a flexible liner for their unique Flex-I-Liner pump that would permit the handling of red and white fuming nitric acid, hydrogen peroxide and other strong oxidizing agents. In addition, high flexibility had to be combined with positive sealing efficiency to protect the rotor, shaft and bearing from contact with the corrosive chemicals. For almost six years Vanton engineers tested various liners and found none that could withstand these unusually severe specifications. Then they turned the problem over to C/R Sirvene engineers. They got the liner they wanted in a matter of weeks. C/R's Sirvene liner, based on the Kel-F elastomer, meets every specification and has been performing dependably for as long as 14.7 million cycles.

If you have a sealing problem—equally critical or simple—C/R Sirvene engineers can help you. They're recognized leaders in the compounding and molding of elastomers for fluid sealing and related applications. They have the research and facilities to solve your problem quickly and economically. Write them direct—or send for the informative new booklet, "Sirvene."

See us at the Design Engineering Show, Booth 616-618

SIRVENE C/R DIVISION

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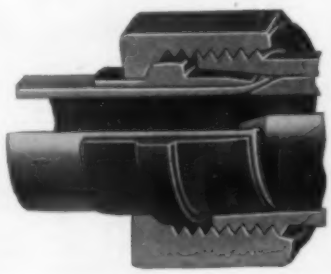
FLODAR
Self-Flaring
HYDRAULIC TUBE FITTINGS

Secret of the exclusive Flodar Self-Faring seal. Drawing reveals how tube is automatically flared when molybdenum steel sleeve is pressed into flared mouth of connector body as nut is tightened to a stop.

You save time and costly preparatory work with Flodar's unique Self-Flaring Hydraulic Fitting. Simply connect the tube, nut and patented sleeve to the connector body, tighten to rockbottom with a wrench —and your leak-proof connection is made. No tube-shearing, no pre-work, no leaks . . . and Flodar Self-Flaring fittings can be repeatedly assembled and disassembled without fear of leakage.



Phantom illustration shows Flodar Self-Flaring hydraulic fitting with nut turned wrench-tight in rockbottom position.

FEATURES OF SELF-FLARING FITTING

- Makes perfect joint because tubing is internally supported by wedge insert upon which self-flare is made as nut is tightened.
- Reduces Installation Time because mechanical flaring is eliminated.
- Saves Tubing Cost, because fitting does not require costly heavy wall tubing to make good joint.
- Guarantees full, unrestricted flow of fluid through tubing.

FLODAR LINE OF FITTINGS IS COMPLETE

No-Flare Style

Flodar No-Flare Fittings are of three-piece construction with 3-point support for stronger tube assembly. They absorb excessive vibration, feature an alloy steel sleeve to grip the tube which creates burnished sealing surface.

Flare Type Fittings

Flodar Flare type fittings are made to exacting dimensions, assuring perfect sealing. The internally tapered alloy steel sleeve perfectly matches tubing flare, firmly coins flare against connector body seat as the nut is tightened.

Other Flodar Products:

Self-Coined Metal-to-Metal Porthole, O-Ring Porthole and standard High Pressure Pipe Fittings.

Stocks in all Principal Cities

Write for our New Illustrated Catalogs

FLODAR CORPORATION

16911 St. Clair Avenue
CLEVELAND 10, OHIO

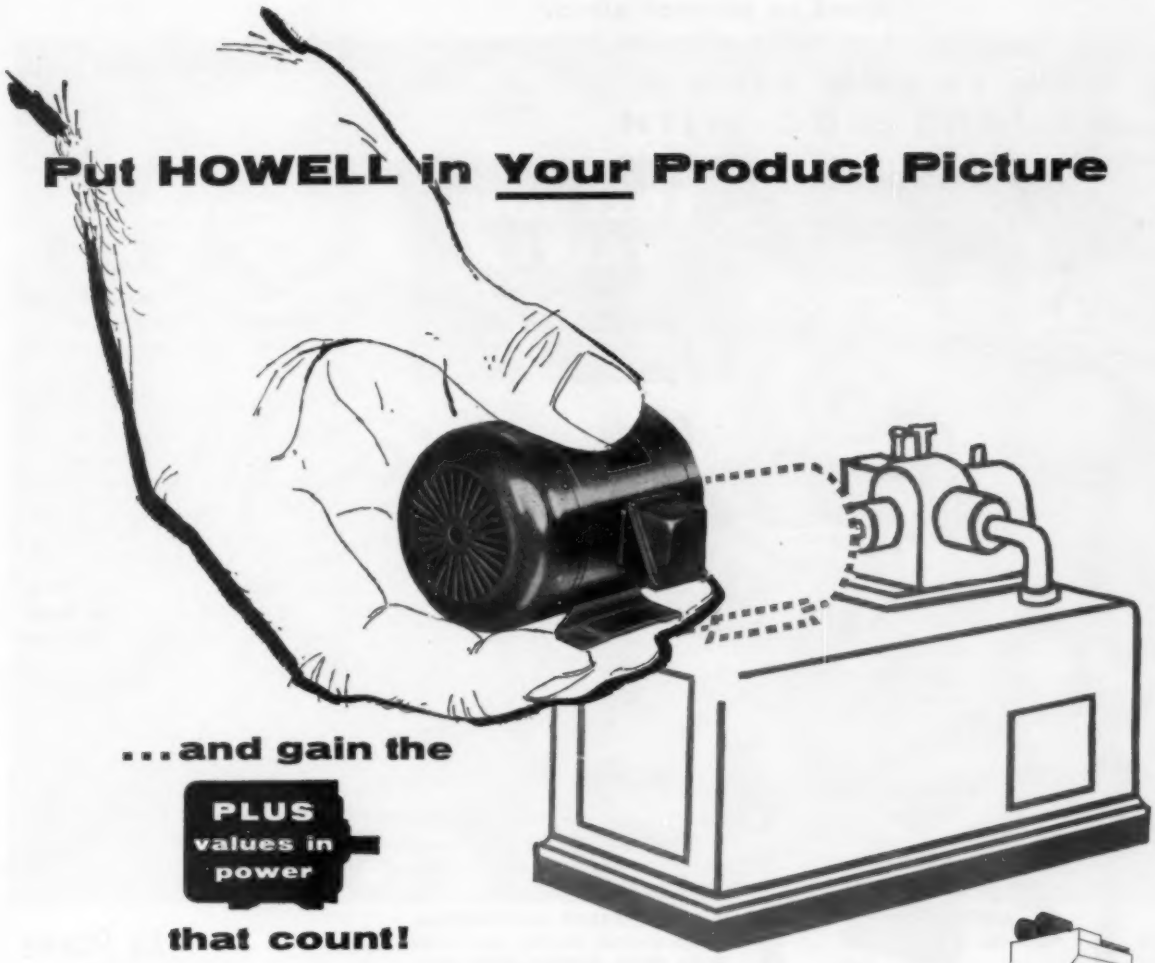
BRIEFS continued

comments and revisions proposed by NFPA members are being submitted for consideration.

- **Fluids**—Fluids activity is moving forward at an accelerated pace. Primary goal is a minor revision, within the next six months, of the fire-resistant fluids booklet released two years ago. The secondary goal is a complete analysis for changes of presentation, project details, supplementary material, expanded bibliography, and inclusion of recent developments. The next basic projects are "Extreme Temperature Hydraulic Fluids", and "General Purpose Hydraulic Fluids". Concurrent with this work are companion projects such as "Effect on Packings, Hose and Seals".
- **Ratings**—Rating work at present continues to remain in the exploratory stage. A basic workbook has been prepared which represents the work done in the past. Rating is a complex problem. Terminology and measurements are important factors.
- **Coding**—A revised Dimensional Code for Cylinders has been prepared which utilizes the start of the threads as the reference point instead of the flange surface. The revised code eliminates subtraction of dimensions and reduces the number of additions necessary to a bare minimum. The code is adaptable to various end profiles. The revised code has considerable merit. In all probability a meeting of cylinder manufacturers will be called soon to consider the code.
- **Cylinder Dimensions**—The questionnaire, project details, instructions, and survey sources for the project "Target Cylinder Bore and Rod Sizes Preferred for Future Designs" has been completed by the project team. The material was reviewed by the members of the Technical Board, and has been sent to the Board of Directors for action.
- **Port Seals**—A functional adaptability summary form is in the final stage of preparation. The

Continued on page 36

Put HOWELL in Your Product Picture



...and gain the

PLUS values in power

that count!

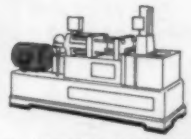
No matter how efficiently designed your hydraulic equipment may be, in operation its dependability rests . . . year in and year out . . . on the motors you select to power it. That's why manufacturers and users of hydraulic machinery, from simple pumps to the largest presses, are specifying Howell motors in ever increasing numbers. Here are a few of the reasons:

EXTRA DEPENDABILITY that challenges the years. Howell's new principle of heat-source ventilation . . . double sealed bearings . . . tough rolled steel frames and precision fitted cast iron end plates . . . these and many more are plus values that *count!*

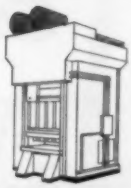
AN UNSURPASSED REPUTATION for engineering excellence and quality manufacture . . . built up by Howell in over 40 years of serving industry's motor requirements.

TOPS IN APPEARANCE. No other industrial motors have such smooth, unbroken contours . . . without an external fin or rib to mar their looks or catch dust deposits.

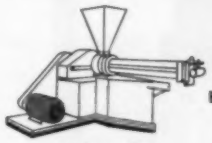
Howell makes virtually every type of AC industrial motors . . . fractional and integral to 300 hp, in all standard enclosures, in both rerated and non-rerated frame sizes, and in many pump mountings. Howell part winding motors, for economical reduced voltage starting of pumps may be of special interest to you.



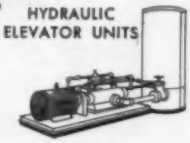
DIE CASTING MACHINES



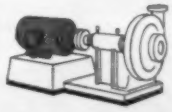
HYDRAULIC PRESSES



EXTRUDERS



HYDRAULIC ELEVATOR UNITS



FLUID TRANSMISSION PUMPS

Howell motors are specified and used by these leading manufacturers of hydraulic equipment:

The Denison Engineering Co. • Hydraulic Press Manufacturing Co. • Rotary Lift Co. • Globe Hoist Co. • Century Hydraulics, Inc. Haughton Elevator Co. • Michigan Drill Head Co.

A Howell sales engineer can give you valuable assistance on any motor application. Wire or 'phone collect . . . or drop us a line . . . you'll get prompt action. Howell Electric Motors Co., Howell, Michigan.

HOWELL *motors*

. . . precision built for industry since 1915

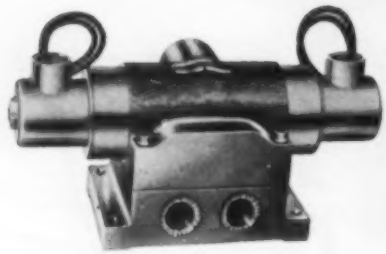
Want to control air or hydraulic circuits electrically?

GET THESE FIVE ADVANTAGES WITH

Modernair

SOLENOID VALVES

for air or hydraulic service to 150 psi



MV SERIES double solenoid for 3 or 4-way operation in ¾" and 1" port sizes is only 13¾" long. Shown with removable sub-base; also available in threaded body, and with single solenoid.

MV SERIES single solenoid in ⅜" and ½" port sizes is only 7¾" long. Available in same styles as larger MV, at top.

Ultra-compact BV series with ¼" ports is only 4½" long; made in single or double solenoid for 3 or 4-way operation.

1. "O" RING SEALING for extra-long service life, easy replacement without removing valves from line.

2. NON-CORROSIVE CONSTRUCTION throughout — cast aluminum body, brass porting sleeve, aluminum sliding spool.

3. COMPACTNESS... note dimensions, figure the space you'll save!

4. EASY INSTALLATION... MV Series are available in threaded body or removable sub-plate or manifold mountings; BV series has rectangular body with flat surfaces for easy mounting.

5. WIDE SELECTION... Modernair offers a full range of port sizes, (¼", ⅜", ½", ¾", 1") in single or double solenoid types, for 3 or 4-way operation; solenoids available for either a.c. or d.c. in all popular voltages.

WRITE TODAY for new 20-page condensed catalog (filed in Sweet's 1957 Product Design File, Section 6a/Mo), and applications data; please address Dept. B-5.

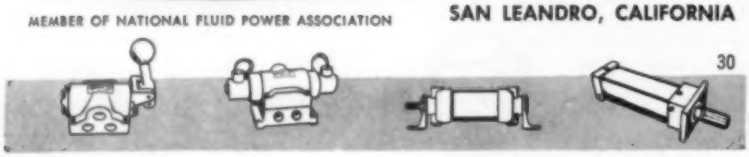
Modernair

CORPORATION

400 PREDA STREET

SAN LEANDRO, CALIFORNIA

MEMBER OF NATIONAL FLUID POWER ASSOCIATION



30

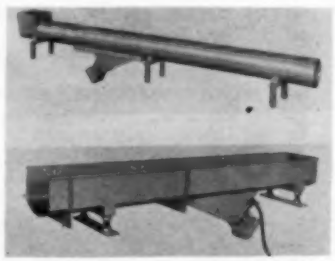
BRIEFS continued

form will include the many operating conditions of fluid power systems. Each manufacturer will be requested to supply appropriate information relative to his type of seal. Users can then quickly determine which type of seal best meets their operating conditions.

• **New Officers**—October 23, 24, 25 are the dates of the Fall Meeting of NFPA, to be held in Washington, D. C. New officers elected at the Spring Meeting are: Ray Murphy, Kalamazoo Div., The New York Air Brake Co., president; Jack Marsh, Rivett, Inc., and Lynn Charlson, Char-Lynn Co., first and second vice-presidents. Board members elected at this meeting are: David Fromson, Greer Hydraulics, Inc.; Wilson Cole, Simplex Engineering Co.; G. R. Pittman, Hydraulic Power Div., HPM; O. G. Lear, Fluid Controls, Inc.; and John Goldring, Modernair Corporation. ▼▼▼

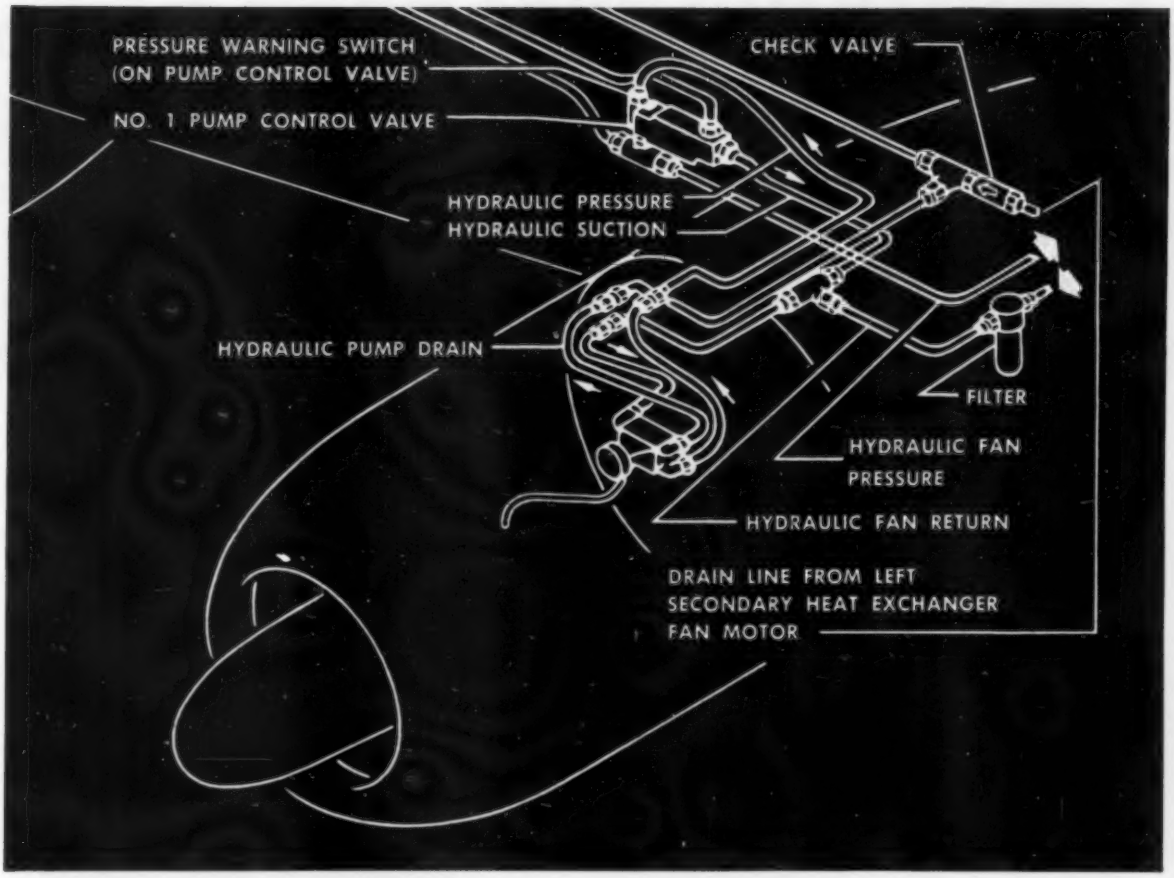
Air Powers Vibrating Feeder

Using pneumatics, operation is completely feasible under conditions that are impossible for conventional equipment.



Designed by The Cleveland Vibrator Co., this feeder uses an air cylinder to generate the vibrating force. Rates of feed are easily changed and adjusted. The frequency of vibration is selected by varying the operating air pressure over a range of 30 to 90 psi, providing control of feed rates. ▼▼▼

Continued on page 40



Where you can't afford a failure...
Plan a Purolator filter as part of your system

Most hydraulic systems break down immediately unless they are protected by adequate filtration. And it takes more than correct filter placement to assure adequate filtration — it takes the best filter you can get as well. That's why it pays to use Purolator Micronic® filters. They give you the fullest protection. The reason? Micronic elements — which provide controlled porosity and maximum filtration effectiveness with removal of particles as small as .000039 inch. And because they're made of plastic-impregnated cellulose, Purolator's Micronic elements are not affected by high temperature or water.

Filtration For Every Known Fluid

PUROLATOR

PRODUCTS, INC.

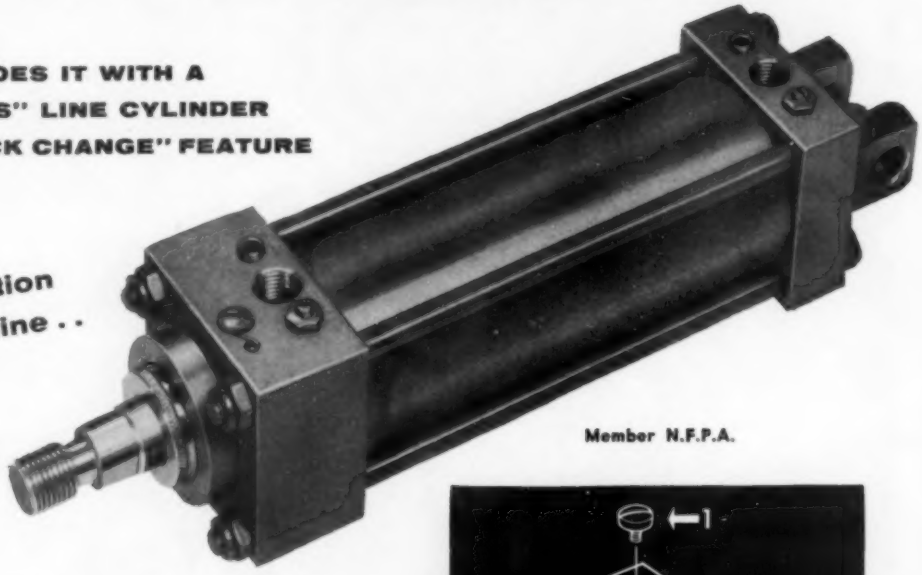
Rahway, New Jersey and Toronto, Ontario, Canada

To find out more about proper placing of filters in hydraulic systems, write for our new 32 page "Filtration Manual for Product Designers"—and please enclose 25¢ to cover postage and handling. Address Dept. P4-526.

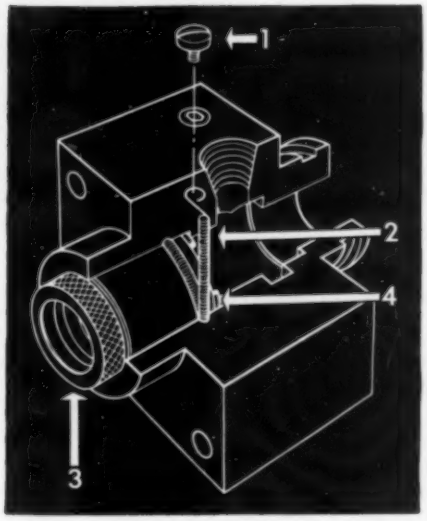
Minute Maintenance
CUTS COSTLY DOWNTIME . . .

EASY DOES IT WITH A LINDBERG "S" LINE CYLINDER WITH THE "QUICK CHANGE" FEATURE

Newest addition to a proven line . .



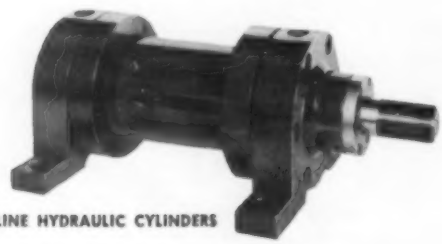
Member N.F.P.A.



That's right, with a Lindberg "S" Line cylinder you can replace, if necessary, "U" cup Rod Packing, "U" cup Wiper, Cartridge Seal or the entire Rod Cartridge Assembly *in minutes*, without special tools or equipment.

HERE'S HOW: Remove Retaining Screw (1) (see cutaway, right) • Strip out Rod Cartridge Retaining Spring (2) • Twist Rod Cartridge (3) to free from Rod Cartridge Seal (4) and withdraw from Rod End Head • Reverse procedure to assemble and you're back in business—without a long, costly delay.

"S" Line cylinders last longer too. Chrome plated steel tube honed mirror bright • Chrome plated manganese steel Piston Rod • Tie Rods—pre-stressed to carry equal load • Full floating cushions • 23 other soundly engineered features mean extra life and lower per hour cylinder costs for you. 7 bore sizes to 6" —Rated 250 psi pneumatic, up to 1000 psi hydraulic—Mounting styles to fit your needs—Standardized mounting dimensions—Built to JIC recommendations. Send today for your copy of Bulletin S-101 on Lindberg Squarehead "S" Line Cylinders.



"H" LINE HYDRAULIC CYLINDERS

OTHER VERSATILE LINDBERG CYLINDERS

2000 PSI "H" LINE—Hydraulic—Shown left, bore sizes up to 8", with or without cushions, standard or 2:1 rods, mounting styles to fit your needs • "A" LINE—Air or Hydraulic—A rugged, non-tie rod cylinder for air pressures up to 150 psi and low pressure hydraulic service • MILL TYPE AND OTHER SPECIALS—For information, send outline of your requirements.

Write for free literature and the name of our representative near you.

TEER-WICKWIRE & CO.

LINDBERG AIR AND HYDRAULIC DIV. • 1802 WILDWOOD AVE., JACKSON, MICHIGAN

Circle 149 on Reader Service Card

Circle 84 →

a rare combination

QUALITY

The recognised Keelavite standards of high quality maintained throughout.

INGENUITY,

Patented features include precision hydraulic location, eliminating wear plates

SIMPLICITY

Four components only achieve the ultimate in simplified construction.

ECONOMY

The end result is a quality pump of high efficiency at a very low price.

The new range of

Keelavite GEAR PUMPS

G.P. SERIES

THE RANGE COVERS SIZES FROM 4 TO 28 G.P.M./1000 R.P.M.
MAXIMUM PRESSURE 2000 P.S.I. — PEAK SPEED 3000 R.P.M.

THE RECOGNISED AUTHORITY ON HYDRAULIC POWER TRANSMISSION

KEELAVITE ROTARY PUMPS & MOTORS LTD., ALLESLEY, COVENTRY *Telephone: Meriden 441.*

Canadian Agent: JOHN SPOTTON CO., LTD., 21 CARSON ST., TORONTO 14, ONTARIO

there's
NO
Dirty
Streak
on the
Rod
with the
Fall
"CJ"

Closed Joint WIPER RING
SPRING LOADED
with
Squeeze Grip Action

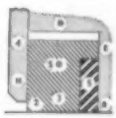
The FALL "CJ" Wiper Ring removes all dirt adherring to the piston rod as well as preventing dirt passing through the joint of the ring itself. FALL Wiper rings are Spring Loaded and the **Endless Spring in O.D. of Ring Maintains a Continuous Squeeze Grip Action on the Rod** preventing ring from ever opening up assuring automatic "take up" of all wear and elimination of any "build up" between rod and ring. The closed joint feature in FALL "CJ" Wiper rings means piston rod is kept clean on its entire O.D. . . . nothing passes through the joint or under the ring. Moisture, liquids, etc. are sealed out when certain of our rubber seal features are incorporated in ring.

CLOSED JOINT

SPRING LOADED

SQUEEZE GRIP ACTION

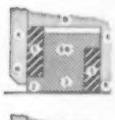
SEALS OUT



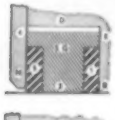
Spotty, Erratic Contact of Ring on Rod is Eliminated in Any Temperature

To avoid possibility of metal fragments detaching & entering packing gland or bearings AFTER ring is installed, we pre-actuate each ring with out factory DRY-LAP PROCESS. This creates a "worn-in" **light tight** true circle wiper edge to the ring.

DRY-LAP PROCESS



LIGHT TIGHT



Use of FALL Wiper rings started during World War II by the Army, Navy & Air Force, in aviation equipment & has been used by them ever since. FALL rings are popular with Industry **because they do the job** which accounts for their wide use in both hydraulic and air installations. Available from ½" dia. upwards in either bronze or cast iron. If you have a wiper ring problem write, wire or phone us.

Five types of many Fall "CJ" Wiper Rings are shown above.

All FALL Rings covered by patents issued or patents pending.

ACE PRODUCTS CO.,
Toledo 1, Ohio
Phone Cherry 3-6513

Fall Wiper Ring SPRING LOADED

You Can Depend on ACE Products
—Established 1935!

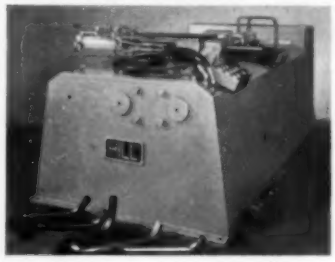
BRIEFS continued

Hydraulic Bending Machine Features Accuracy

This press-type bending machine, designed by Walter P. Hill, Inc., Detroit, Mich., is a compact, horizontal-type, hydraulic-powered machine. Tubular parts in which two or more bends of varying angles must be in accurate relationship are produced at high speed.

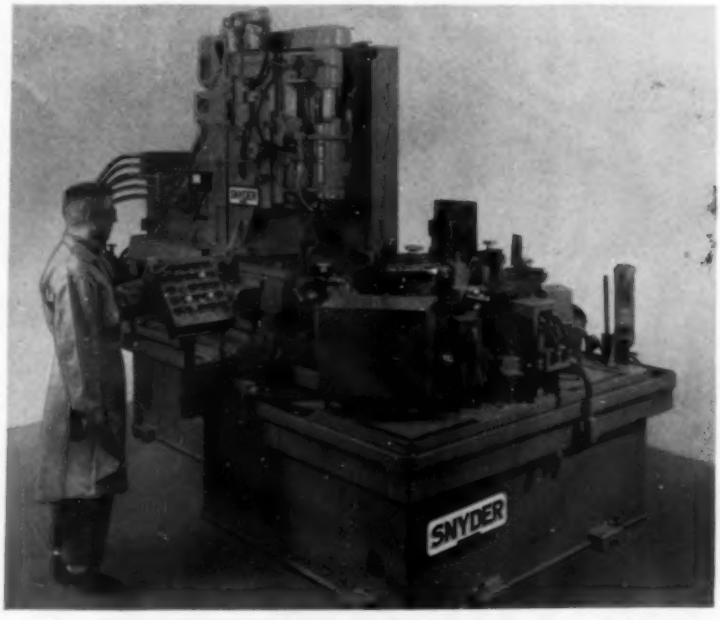
• **Accuracy**—Bend relationship accuracy is assured by clamping one end of the tubular part and holding it stationary while a bend is produced on the other end by a hydraulic-powered press ram and wiper die assembly. This provides maximum operator safety, and allows other bends in the part to be produced in sequence in accurate relationship.

• **Hydraulic control**—The wiper die and mandrel assembly move with the tubing as it is bent, thus avoiding die marks and wrinkles in the bent parts. Travel



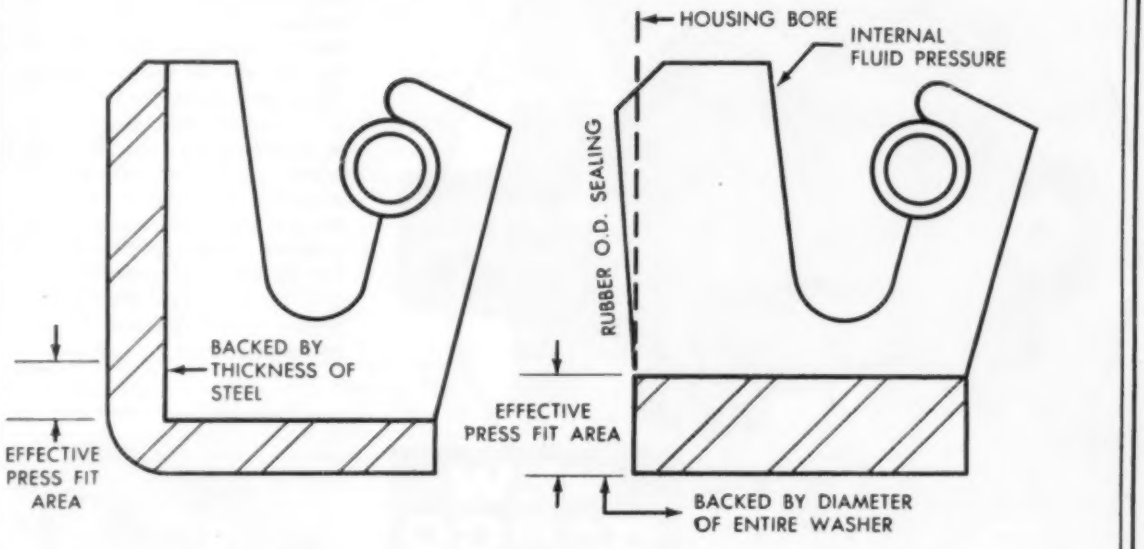
of the press ram wiper die assembly can be controlled in sequence to produce bends of different angles in a single part in an automatic bending cycle.

Continued on page 42



This hydraulically operated, electrically controlled machine performs five complex milling operations with minimum tool changes and part handling. Designed and built by Snyder Tool & Engineering Co., the machine is a typical example of operation simplification and savings in floor space that can be achieved by incorporating suitable controls and drives in a special unit for low production requirements. Hydraulic power is provided by a separate motor, pump and tank unit.

Which bonded Seal would you select?



That, of course, depends on your specific problem, but IPC custom designs and molds either type

Illustration A shows a typical design for bonded case seals. Note the area designated as "effective press fit". This is a crucial sealing area above the rounded shoulder of the seal and in this type of construction the "press fit" area is not directly in line with the base of the seal, but is backed by the thickness of the case material and the shear area between the O.D. of case and base of seal. This type of seal is easily installed.

However, in illustration B there are other advantages . . . First, note the thickness of the washer with its squared-off area at the base of the seal. Here the "effective press fit" area is in direct line with a large mass of material. The "press fit" is supported by the entire mass of metal in the heavy washer. This type of seal is especially effective when internal fluid pressures are high and can force the rubber out against the bore. They seal more securely . . . over a longer period of time. Real economy here, too!

Both types of IPC bonded seals are far superior to the old combination of a molded rubber member inserted into a rolled metal case.

That's a quick look at IPC's thoroughness. Whatever your application, IPC will draw on experience and custom compounding skills to provide you with the best solution. Ask your IPC representative for the facts on IPC leather and synthetic oil seals, packings and precision molded products.

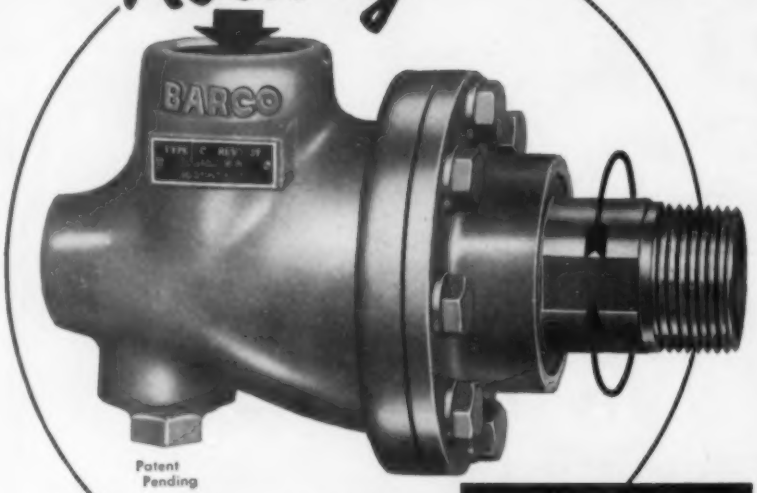
PACKINGS • OIL SEALS IPC PRECISION MOLDING

INTERNATIONAL PACKINGS CORPORATION

Bristol, New Hampshire

P3

NOW-A Better Rotary Joint!



Patent Pending

SIZES
½" ¾" 1" 1¼"
1½" 2" 2½" 3"

NEW BARCO TYPE C Rotary Joint

Announcing...

It's new! It's simple! It's versatile! And for countless applications, Barco's new Type C Rotary Joint will give you the best operating records you've ever had. ●

FOR ALL SERVICES—One basic style of revolving joint for single flow or syphon flow ... one basic seal for steam, air, water, oil, gas — *or alternating hot and cold!* For temperatures to 450°F. Special to 500°F.

NO LUBRICATION NEEDED — Bearings and seal self-lubricating. Seal self-adjusting for wear. Long life without repairs or maintenance.

LOW TORQUE — Low starting and running torque*. Saves power. Suitable for any ordinary speed. To 200 psi, steam, or 400 psi, hydraulic.

COMPACT, SIMPLE — Malleable iron body; heat treated steel shaft; R.H. or L.H. thread. Eight sizes, ½" to 3".

**Typical example: 12 in. lbs. starting torque for 1" Type C on 100 psi water. Rotating torque, same.*

SEND FOR NEW CATALOG 310 TODAY.

FOUNDED 1908 BARCO PRODUCTS BACKED BY EXPERIENCE

BARCO MANUFACTURING CO.
532F Hough Street • Barrington, Illinois

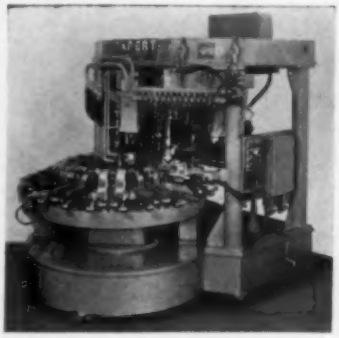
The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Revolving Joints
In Canada: The Holden Co., Ltd., Montreal

BRIEFS continued

The die block is closed by a 4-in. hydraulic cylinder, clamping the part for bending. A bending mandrel is advanced into the part by a 2-1/2-in. hydraulic cylinder, and the bend is made by an 8-in. dia. hydraulic cylinder. During the bending operation, the wiper die mandrel and its control cylinder follow the bend under the control of a 3-1/2-in. hydraulic cylinder.

● **Components**—The hydraulic system operates at 1000 psi and is powered by a 30 hp motor. A 40 gpm pump operates the ram, mandrel and wiping die cylinders. The die clamping system is powered by a separate 2000 psi hydraulic system, powered by a 5 hp motor and a 3 gpm pump.

▼▼▼



Welding guns are hydraulically powered on this automatic, 12-station, index welder developed by Expert Welding Machine Co. Stationary work clamps in the 24 fixtures are air-operated. Ejector mechanisms, also air-powered, separate the parts and deposit them on conveyors. An integral motorized hydraulic pump and tank unit supplies power to the welding guns.

Small Hydraulic Actuator Operates Large Valve

Problems of size and cost have been solved by the miniaturization of hydraulic actuation achieved by Oil-Dyne, Inc., Chicago, Ill. The complete unit to actuate a 12 in. gate valve—pump, pressure switch, cylinder, reservoir and motor—is dwarfed by the size of the valve itself. Yet this compact, power-packed hydraulic unit actually

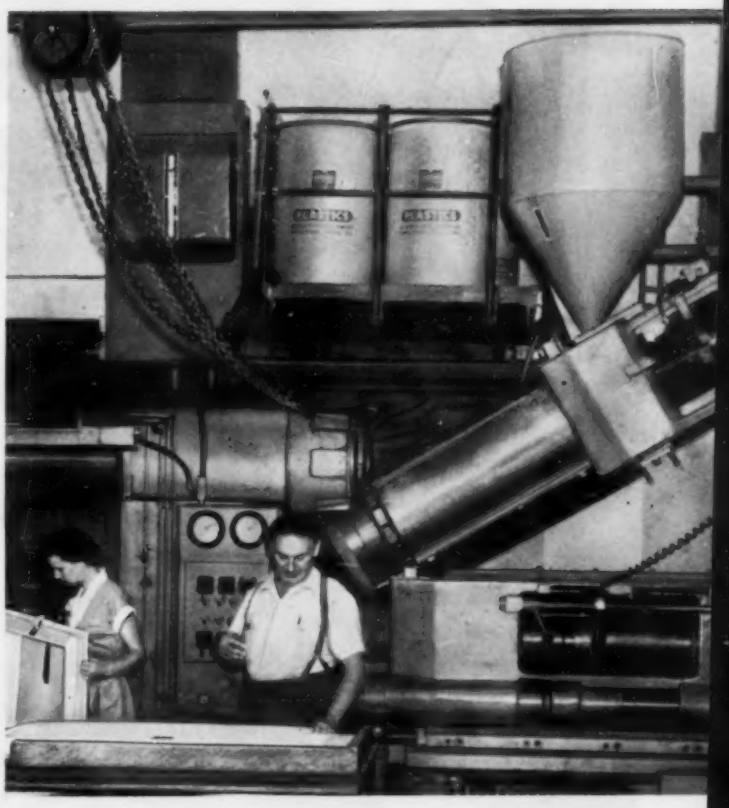
Continued on page 44

Circle 19 on Reader Service Card

Circle 144

A STANDARD OIL product and technical service help plastics molder

Standard men and STANOIL Industrial Oil aid General Machine & Tool Works in getting top performance from injection molders.



General Machine & Tool Works, Walled Lake, Michigan, has had 12 years' experience with STANOIL Industrial Oil and Standard Oil Company technical service. The experience has been rewarding. Plastic injection molding machines, equipped with STANOIL Industrial Oil 12 years ago, are still using this same hydraulic fluid. The equipment operates with minimum servicing attention, and only minimum make-up oil is required.

A Standard Oil industrial lubrication specialist, L. H. Walker, began working with General Machine management in 1945, after competitive oils had been tried. Machines were converted to STANOIL, and Lyman Walker initiated regular six-month checks on the performance of the oil. In addition, he helped plant management install a portable filtering system so that the oil could be filtered completely about every two months.

The Kovacs brothers, Andrew and George, founders of General Machine & Tool, are more than just operators of an injection molding business. They are designers of equipment as well. So part of the technical service Lyman Walker provided the Kovacs was engineering information about lubricants and lubrication procedure. Men who have succeded Lyman Walker in serving this plant continue to keep the Kovacs up-to-date.

Today, 15 plastic injection molding machines are operating at General Machine & Tool Works. All use STANOIL Industrial Oil. Included in this list of equipment is the giant Watson-Stillman 400-ounce injection molder—the world's largest. A 300-ounce machine is likewise getting top performance from STANOIL Industrial Oil.

Get facts about STANOIL Industrial Oil and get this kind of technical service as well. Call the Standard Oil office near you in any of the 15 Midwest and Rocky Mountain states. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

Quick facts about

STANOIL Industrial Oil

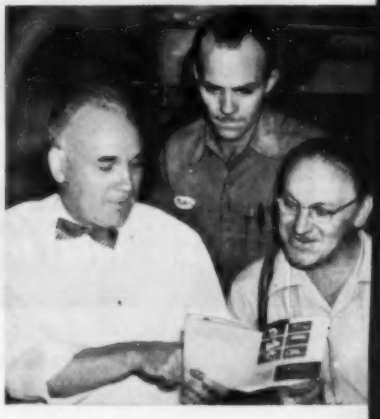
- Antioxidant gives oil resistance to chemical change, minimizes deposits.
- Inhibitor "plates out" on metal surfaces, prevents corrosion.
- Refined to eliminate emulsion problems. Contains additive to minimize foaming.
- Low pour point. Flows freely from cold start. Needs no warm-up.
- High viscosity index. Resists temperature change.

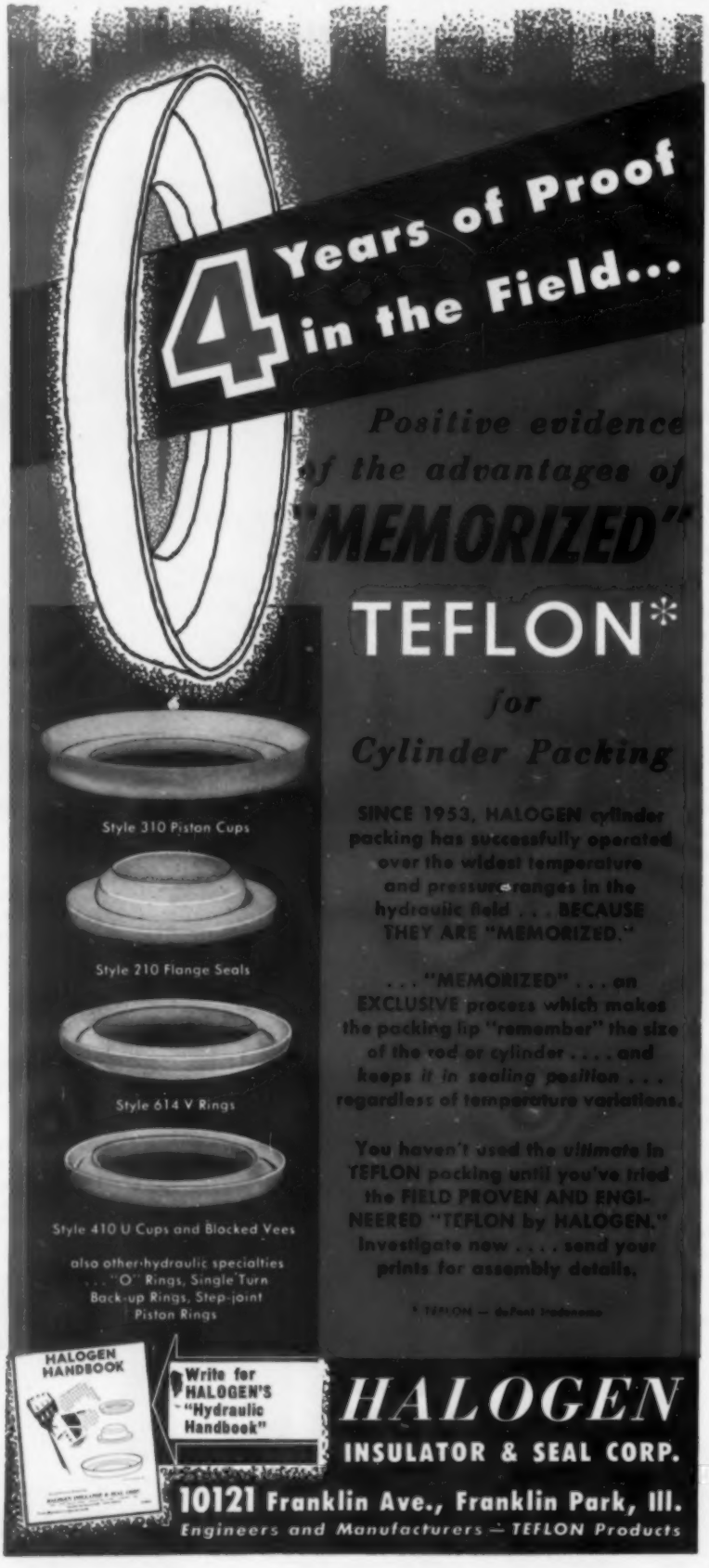
George Kovacs and plant superintendent check refrigerator door liner, world's largest individual molded part. Many special features of the 400-ounce plastics machine were designed by Kovacs brothers, owners of General Machine & Tool Works.

Walter Spain, Standard Oil industrial lubrication specialist, goes over STANOIL literature with plant superintendent, Owen Pierce, and General Machine & Tool Works president, George Kovacs. Supplying lubrication information and technical service to customers is something for which Walt Spain is well qualified. He has been doing such work for 23 years. Walt got his engineering training at Virginia Polytechnic Institute. He has also completed the Standard Oil Sales Engineering School.

STANDARD

STANDARD OIL COMPANY (Indiana)

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BRIEFS continued

does the same job as an electrically-driven gear motor.

● **Two pressures**—Opening and closing of valves is a natural application for hydraulic units, as two separate and distinct pressures, one for closing, and one for opening, can be provided. Due to

the tapered wedge and seat found in gate valves, greater pressure is normally needed to open the valve than to close it, particularly if the valve has been closed for some time.

On one application, a closing pressure range of 2000 psi is provided on one side of the cylinder, and an opening pressure range of 3000 psi on the other side. Any combination of 50 to 5000 psi could be provided.

● **Compact**—Miniature hydraulic actuation offers advantages, especially on larger size valves and applications where higher pressures are involved. The complete, self-contained, hydraulic power unit takes up less room than a conventional hand wheel, and has all elements necessary to transform a push button signal into a high force motion. ▼▼▼

Recent Publications

Aircraft Hydraulics, Volume One—Hydraulic Systems: Edited by H. G. Conway. Published by

Continued on page 46

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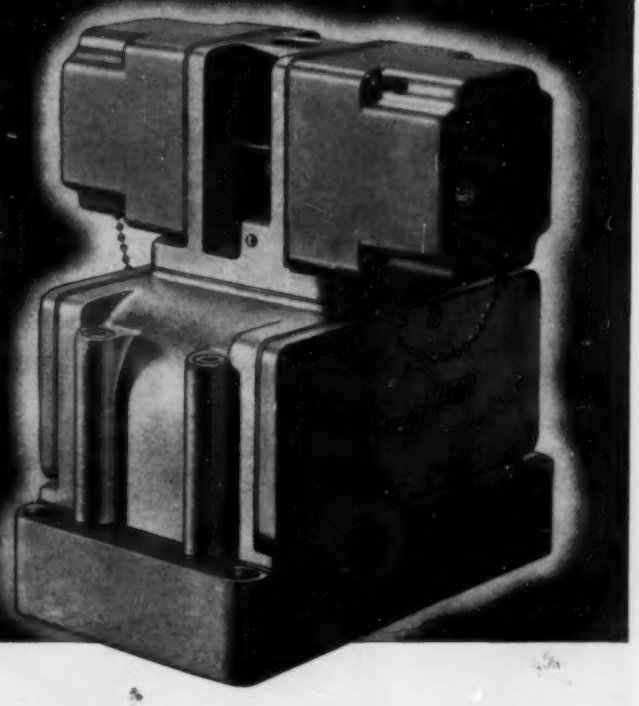

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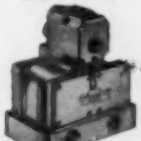

410 SERIES
4-Way
Single Solenoid
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320 SERIES
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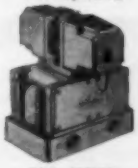

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CATALOG 105 describes all the NOPAK-MATIC Plus Values in detail, gives complete installation and parts data. Send for your catalog now and it will be forwarded promptly. NOPAK-MATIC *Plus Value* Valves are available in ¼", ⅜", ½" and ¾" pipe sizes for 2-, 3-Way Normally Open or Normally Closed or 4-Way operation with master (air), single or double solenoid pilot control heads.

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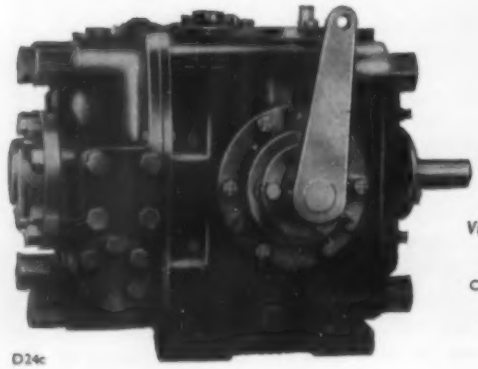
"DENNY-BROWN" STABILISERS

Yet another example of the highly varied operations to which 'VSG' hydraulic pumps are applied is provided by the Denny-Brown stabilisers fitted to many vessels, including R.M.S. Queen Elizabeth. The 'VSG' pumps are incorporated in the mechanism for actuating each of the four fins.

One of the two port fins of the Queen Elizabeth Ship Stabilizer



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BRIEFS continued

Chapman & Hall Ltd., London. 146 pages; illustrated; Price 35 shillings.

Published under the authority of the Royal Aeronautical Society, this is the first of a series of textbooks to meet the needs of students and engineers in this field. This first volume is concerned with general problems of hydraulic systems. Volume 2 will discuss component design. Volume 3 will discuss landing gear design.

Volume 1 includes well illustrated chapters on fluids, hydraulic theory from the aircraft standpoint, general system problems and corresponding circuits, and system installation and development testing problems. Many tables, charts and nomographs are also included. ▼▼▼

Teflon Forms High Pressure Seal

Scientists of the National Bureau of Standards have successfully used Teflon as a packing material in the high-pressure moving seal of differential-area pressure intensifiers. The packing has served effectively at pressures approaching 200,000 psi.

• **Design**—The packing was used with a mushroom plug and extrusion ring assembly. The ram of the intensifier pushes against a cylindrical ring of hardened steel with the stem of the mushroom plug in the center. Held in a framework of copper beryllium extrusion rings, the packing is

Continued on page 50

BRIEF NOTES

10,000 PSI VALVE . . . using shear seal principle has been designed for hydraulic or pneumatic service by Barksdale Valves, Los Angeles. Valve withstands 15,000 psi surges and has a burst pressure of 40,000 psi.

ELECTRIC MOTORS . . . designed specifically for hydraulic pumps by U. S. Electrical Motors, Inc., Los Angeles, feature a special bracket for mounting the pump on the motor. Details in New Products Section.

BUSINESS BRIEFS

FLUID POWER MARKET . . . Pointing to the tremendous growth over the past ten years, Flick-Reedy Corporation estimates $1.5 billion-a-year business for the more than 160 major manufacturers in the fluid power field.

$16 MILLION BACKLOG . . . of orders for precision hydraulic controls for aircraft and missiles has accelerated the expansion program at National Water Lift Co., Div. of Cleveland Pneumatic Tool Co., Kalamazoo, Mich. C. E. Willis, vice president and general manager, also reported 1956 business was $9,468,000—more than double 1955 shipments.

SMALL BUSINESS GOING STRONG . . . in the fluid power field. Bob Skinner, general manager of Skinner Seal Co., Santa Ana, Calif., reports $90,000 business in the first ten months of existence in 1956, and $100,000 in the first three months of 1957. Sales are still climbing and the company expects to reach an annual goal of $1 million by the end of this year.

NEW HIGH IN EARNINGS AND SALES . . . was reported by Murray McConnel, president of Cuno Engineering Corp. Sales were up 15% to a new high of $6,297,000. Specialists in fluid filtration, Cuno expects to maintain its growth in industrial filtration.

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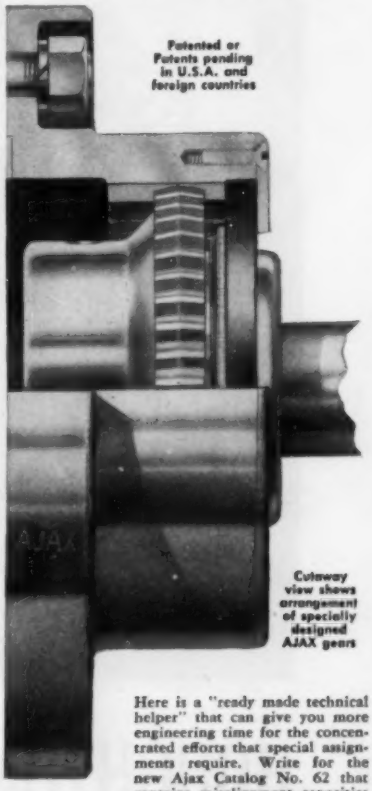

Cutaway view shows arrangement of specially designed AJAX gears

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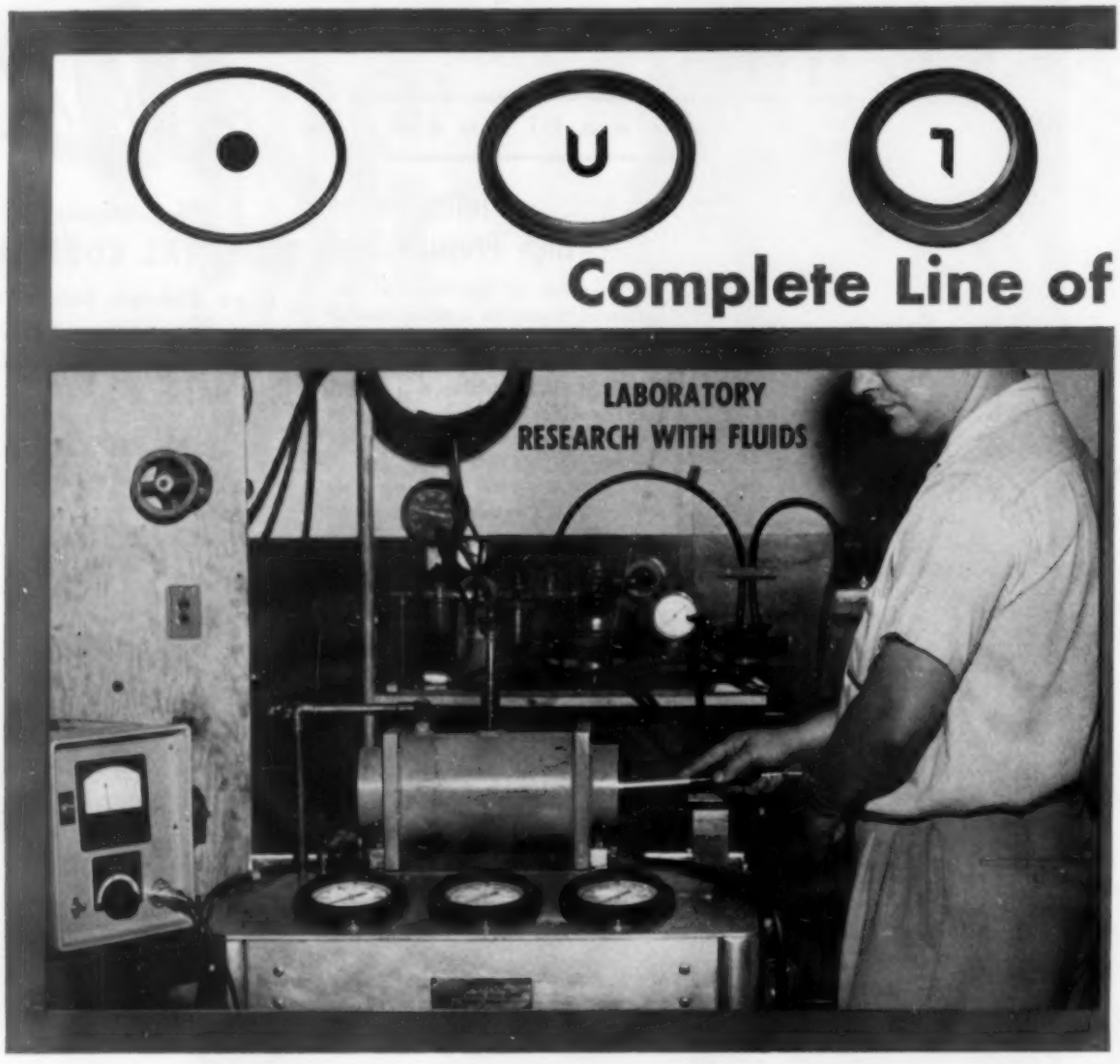


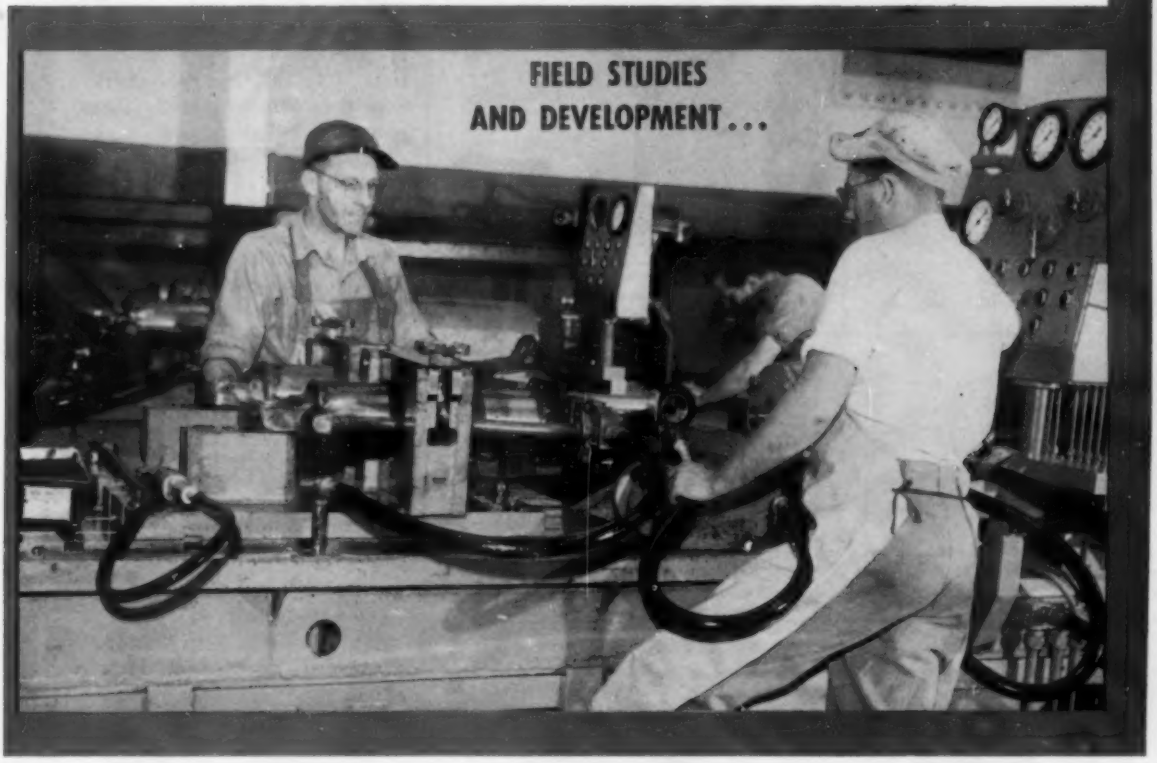
HOUGHTON'S Background in Packings &

Years of hydraulic experience have earned for Houghton a position of leadership in both packings and fluids on which you are invited to cash in.

From this one source, you can get a complete range of sizes in cups, "V's", "U's" and "O" rings in wax impregnated leather, rubber impregnated leather, fabricated rubber and homogeneous rubber. In the field of packings, Houghton's know-how is proven by their leadership in standardization; in unique standard stack height for rubber, fabricated and leather "V's"; in the development of the only thoroughly rubber impregnated leather packings; and the advanced "square shoulder and flare" design of cup packings.

Houghton can also give you the advantages of its leadership in hydraulic fluids. In this field, Houghton was the first to develop a petroleum hydraulic oil specifically fortified to meet the

Types and Materials...



Fluids means Better Hydraulic Products

requirements of hydraulic operation; Houghton pioneered in the development of fire-resistant hydraulic fluids—equipping every U.S. aircraft carrier with fire-resistant Houghto-Safe.

Don't fail to take advantage of Houghton's background in packings and fluids for your application.

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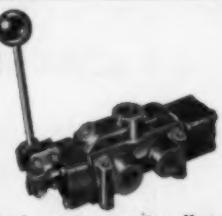
for PEAK PERFORMANCE ADEL Hydraulic Valves and Pumps are setting new and ever higher standards for precision in manufacturing and efficient performance in operation. Following are but a few of the wide variety of models to meet all operating conditions.

GEAR-TYPE HYDRAULIC PUMPS

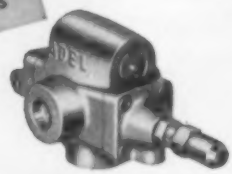
For 1000 psi service with rated capacities at 1800 rpm of from 1.5 to 46.8 gpm.

DIRECTIONAL CONTROL VALVES



4-way valves with spring-centered, spring-offset, and 1, 2, or 3 position detent action. 1500 psi. Flows to 28 gpm.

BY-PASS VALVES



Relief, Sequence and Unloading valves. Direct or remote operation, 50 to 1500 psi range.

VOLUME (FLOW) CONTROL VALVES

Compensated type maintains constant flow over wide differential pressure range. No drain line required. 1500 psi.

PILOT VALVES

2 or 3 position detent. With or without dog or lever. Can be used as 4-way valve in small circuits. 1000 psi.

CHECK VALVES

Valves allow free flow in one direction only. Many variations available. 3000 psi.

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BRIEFS continued

placed in the annular region between the hardened steel ring and the mushroom plug. In this position, the packing isolates the effectively zero pressure in the hollow of the steel ring from the high pressure at the annular surfaces where the packing touches the steel ring and the plug.

• **Results**—Intensifiers packed in this way were found to have from 10 to 15% less over-all friction than similar intensifiers packed with leather.

After more than 100 hours under load, with 18 pressure applications up to between 100,000 and 190,000 psi, one of the intensifiers was disassembled and examined. No signs of packing extrusion were found. In fact, the original tool marks were still visible on the surface of the plastic packing material that had been exposed to the rubbing action of the intensifier wall. ▼▼▼

Hydraulic Muscles For Die Casting . . .

. . . was the title of the talk given by I. L. Kaplan, chief engineer, Lax Industrial Products Co.,

I. L. Kaplan

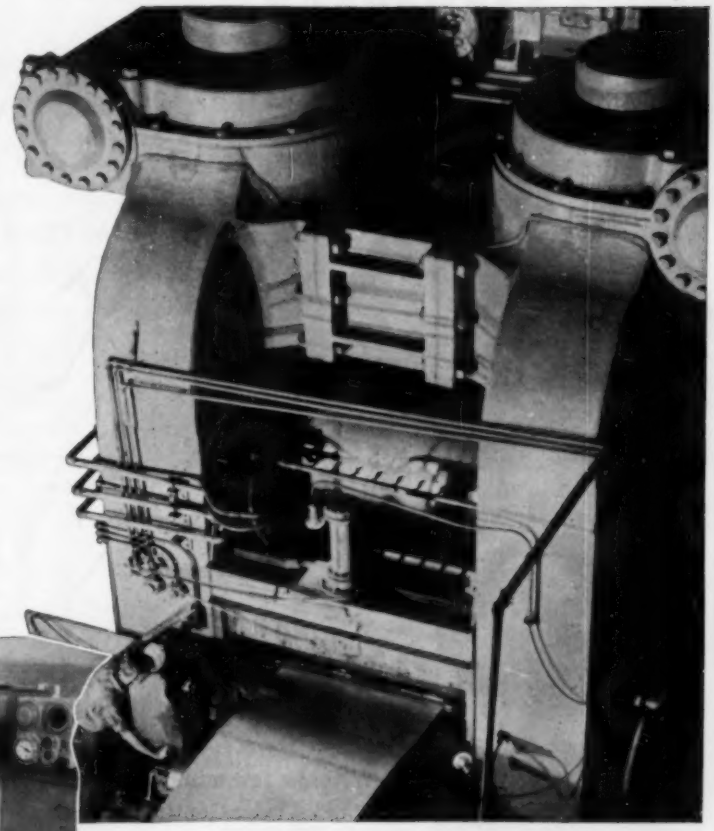
guest speaker at the March meeting of the Cleveland chapter of the Society of Die Casting Engineers.

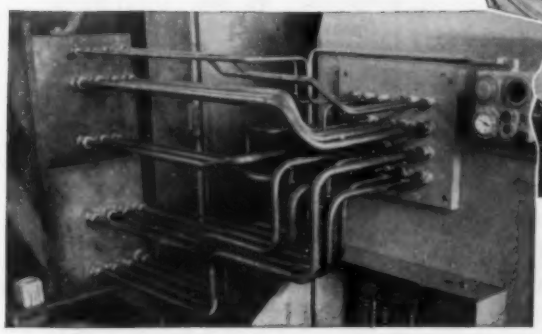
After reviewing basic physical principles of force generation by hydraulic pressure, the various components of circuits for die casting machines were discussed. This discussion included: gear,

Continued on page 52

NOW

...get all the advantages of welded steel tubing for your hydraulic lines.





Republic ELECTRUNITE Electric Resistance Welded Steel Tubing offers positive advantages that cannot be equaled in tube produced by other processes.

Because ELECTRUNITE® is formed from flat-rolled steel, both *inside* and *outside* surfaces can be checked for possible potential defects. The resulting close-tolerance tube wall is *uniform*. The combination of close tolerances and high ductility provides excellent bending and flaring characteristics. And, the tube is not subject to longitudinal or transverse cracks.

Now, Republic is bringing these unique ELECTRUNITE advantages to hydraulic line tubing produced to a highly restrictive specification. That specification is the result of knowledge gained in the manufacture of critical ammunition components. The battle-tested performance of ELECTRUNITE Welded Steel Tubing proved its complete dependability.

Republic ELECTRUNITE Hydraulic Line Tubing can assure unsurpassed performance in your own high-pressure applications. And, it can substantially reduce maintenance costs, especially in complicated installations.

It is available now in a wide range of sizes and in wall thicknesses regularly used in hydraulic applications. It can be used with all standard fittings and accessories. Write for more information about all the advantages of welded steel tubing for hydraulic lines.

SIZE-GAGE RANGE—REPUBLIC HYDRAULIC LINE TUBING

Outside Diameter Inches	NOMINAL WALL THICKNESS, BIRMINGHAM WIRE GAGE									
	20 .035	18 .049	16 .065	14 .083	13 .095	12 .109	11 .120	10 .134	9 .148	8 .165
⅛	X	X								
¼	X	X	X							
⅜	X	X	X	X						
½		X	X	X	X					
⅝			X	X	X					
1			X	X	X	X	X			
1¼				X	X	X	X			
1½					X	X	X	X		
1¾						X	X	X	X	
2							X	X	X	X
2½								X	X	X

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BRIEFS continued

vane and rotary piston pumps; relief valves; pressure-reducing valves; directional valves; flow-control valves and cylinders.

Various hydraulic circuits commonly used on die-casting machines were also described. These included a two-pump or high-low circuit to provide rapid die closing without excessive power losses during the time the dies are closed. Circuit refinements such as flow-control valves to provide inching, and valving to stop the platen at any desired position were covered as well as the use of accumulators to provide high injection speeds and the construction and operation of accumulators.

Mr. Kaplan also detailed the necessary qualities of hydraulic fluids and the importance of following recommendations made by manufacturers when selecting a fluid. Provisions for maintaining the fluid in good condition such as proper filtration and operation at the correct temperature were pointed out as being particularly important to continuing satisfactory operation.

Maintenance, trouble shooting and a recommended procedure for converting from a hydraulic oil to one of the newer fire-resistant fluids were covered in this very complete presentation. ▼▼▼

Electro-Pneumatic Aircraft Valve Actuator Assembly Weighs 1½ Lbs.

To control the amount of hot air mixed with cold air for air conditioning military jet planes and jet transports, Vapor Heating Corp., Chicago, has developed a new line of vapor electro pneumatic valve actuator assemblies. These new actuators and valves are lighter and smaller than electric motor driven valves and lighter than many pneumatic valves.

• **Operates against 300 psi**—The specially designed mechanical-linkage in the actuator makes it possible for these new valves to

Continued on page 56

. . . Fluid Power news

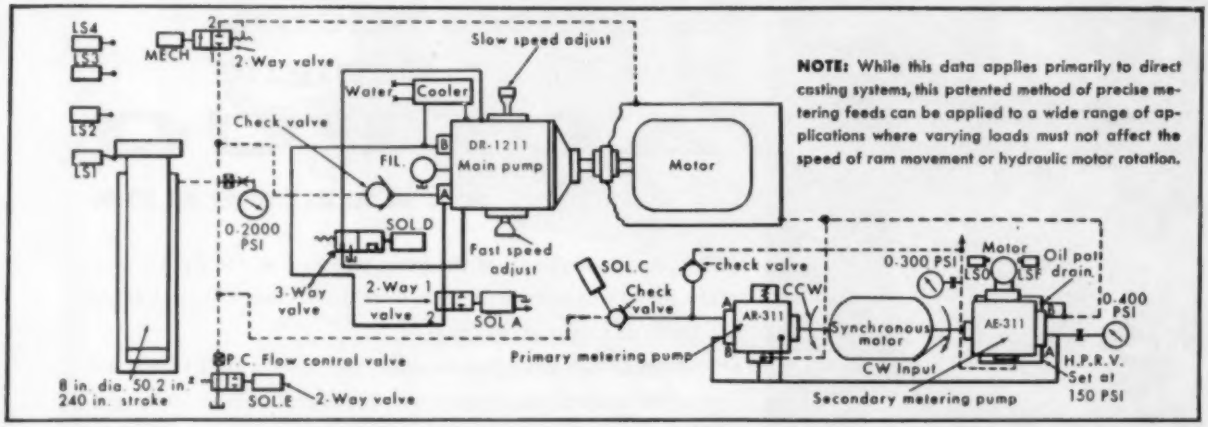
REPORT NO. 11,800 POSITIVE FEED RATES

From Oilgear Application-Engineering Files

HOW OILGEAR SYSTEM ACCURATELY HOLDS DIRECT CASTING FEED RATES

CUSTOMERS: *Large aluminum and magnesium alloy producers*

DATA: Feed equipment for direct casting of light metal alloy extrusion rounds and sheet ingots. The entire cast—or drop—takes about 60 minutes at a rate of 3 ipm to ingot lengths of 15 ft. or more, depending on the size of furnace heat. Avoidance of internal cracking, homogeneity, grain structure fineness and orientation depend on rate of cooling, pouring speed, and subtle control of all variables. Must be "fail-safe" and complete cycle in event of power failure. Casting platform to have both up and down rapid traverse; and controllable, stoppable, steady, slow, down feed rate regardless of platform load.



NOTE: While this data applies primarily to direct casting systems, this patented method of precise metering feeds can be applied to a wide range of applications where varying loads must not affect the speed of ram movement or hydraulic motor rotation.

SOLUTION: A new, patented, Oilgear Fluid Power control system that provides accurate volumetric metering of pressurized oil over a 200:1 pressure range, and a 100:1 feed range. A typical installation consists of an Oilgear "DR-1211" variable displacement pump with 10 hp electric motor on a custom-built base; Oilgear "AR-311", "AE-311" precision variable displacement metering pumps driven by a 3 hp, double-end, synchronous electric motor; an Oilgear 8" bore x 240" stroke, single acting cylinder; and Oilgear valves and controls. The "AR" and "AE" metering pumps are connected in series hydraulically between the cylinder and oil reservoir. During pouring, ram down-feed is dependent on control setting of secondary "AE-311" metering pump—remotely controlled by pushbutton to provide instant, accurate, feed rate adjustment from 0 to 25 ipm. Casting feed rate is indicated in ipm on a direct reading indicator . . . can be preset accurately, and changed at will. Oil under varying pressures flows from cylinder through sealed, "pressurized" type "AR-311" metering pump—and then at a relative constant low pressure through "AE-311" metering pump to reservoir to provide extremely accurate casting feed rates regardless of varying platform load. An automatic, hydraulic control varies "AR-311" pump displacement to compensate for load variation, and feed selected.

TEST REPORT: "Where load on the platform varied the oil pressure from 50 to 1,500 psi, and rate of flow was preset anywhere between 50 and max. cipm, *there was no measurable change in the preset rate of casting feed during any portion of stroke.*"

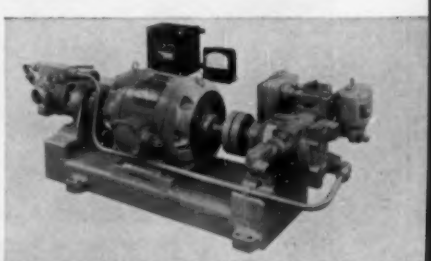
For practical solutions to your linear or rotary drive and control problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY

Application-Engineered Fluid Power Systems

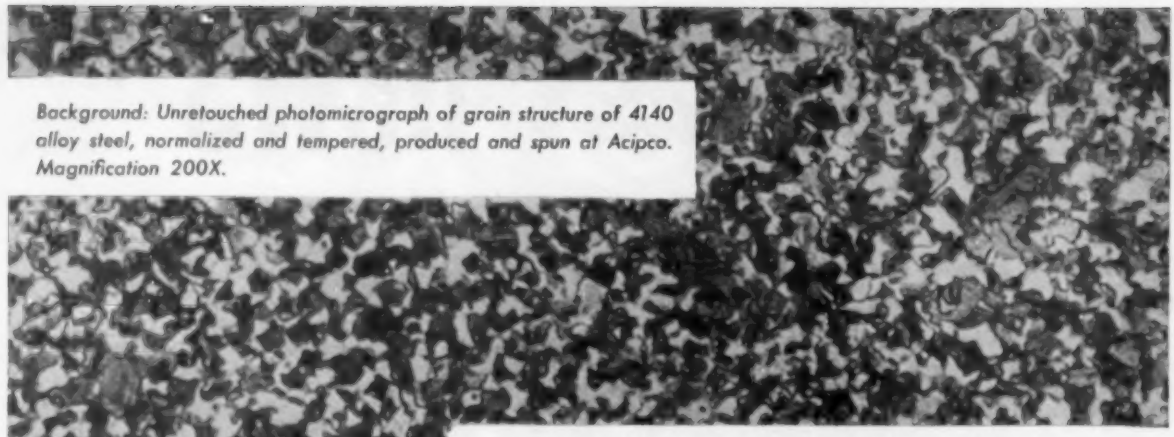
1564 WEST PIERCE STREET • MILWAUKEE 4, WISCONSIN

HERE'S HOW—oil flow is controlled by this new, patented, Oilgear system. When solenoid "A" is energized, oil delivered by "DR-1211" flows out port A to cylinder ram; when de-energized, main pump flow is bypassed. When solenoid "D" is energized, pump delivers maximum volume set by fast speed adjustment; when de-energized, pump delivers minimum volume set by slow speed adjustment. If upper limit switch is over-run due to switch or current failure, mechanically operated 2-way valve is opened by ram overtravel bypassing oil providing fail-safe "up" operation. In normal operation, solenoid "E" is energized, blocking oil flow through flow control valve. If power fails solenoid "E" is de-energized allowing oil to flow from cylinder through flow control valve to continue pouring stroke. Ram can be stopped in this situation by closing flow control valve. When pouring starts, solenoid "C" is energized opening check valve, metering oil through series connected primary and secondary pumps back to the reservoir. All solenoids except "E" are de-energized when ram is in idle position, blocking flow from cylinder to hold ram and platform stationary. Oil from small integral gear pump when blocked by higher pressure on mechanical check valve bypasses through cooler to supercharge main and metering pumps. It also lubricates metering pumps when ram is idle.



Metering pump unit with "AR-311" (left), "AE-311" and gear-head pilot motor to right, direct-connected to a double-end, 3 hp synchronous electric motor.

Oilgear "DR-1211" variable displacement pump provides adjustable, preset, slow and fast speeds for raising (and lowering) the platform. Max. volume is 8,140 cipm for max. "up" speed of 162 ipm at any force up to 67,500 lb. with an 8 inch ram.



Background: Unretouched photomicrograph of grain structure of 4140 alloy steel, normalized and tempered, produced and spun at Acipco. Magnification 200X.

A Better Pattern For Your Designs...

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This photomicrograph of the grain structure of the Acipco steel tube shows why parts made from these quality tubes are both easier to make and more economical to use.

Because it is centrifugally spun, the Acipco steel tube grain structure is more even, more dense, and more free from inclusions. This non-directional granular pattern means easier machining, greater strength, and greater durability in any design.

Non-directional grain structure is only one of the advantages you get when you specify and use Acipco Steel Tubes. If you manufacture or design products requiring tubular steel, write or call for full information about Acipco steel tube applications in your field.

SIZE RANGE: Lengths up to 16′ — longer lengths by welding tubes together. OD's from 2.25″ to 50″; wall thicknesses from .25″ to 4″.

ANALYSES: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steels; plain carbon grades and special non-standard analyses.

FURNISHED: As cast, rough machined, or finish machined, including honing.

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More and more equipment manufacturers and lubrication engineers are learning that fire-resistant Cellulube lubricants provide superior protection against excessive wear during continuous operation under extreme pressures. Tests conducted by The Oilgear Company of Milwaukee, Wisconsin on various fire-resistant fluids showed that Cellulubes "seem to be the most satisfactory fluids for use in Oilgear pumping equipment."

Cellulubes are straight phosphate ester base synthetic oils . . . chemical compounds that contain no additives. Because of this, and because of lower flammability and reduced tendency to form undesirable deposits, Cellulubes can provide excellent lubrication combined with dependable fire protection.

Cellulubes are available for supply in 6 controlled viscosities to meet exacting requirements in the replacement of flammable lubricants presently in use in your plant or equipment. Write for working samples and complete data for a thorough evaluation.

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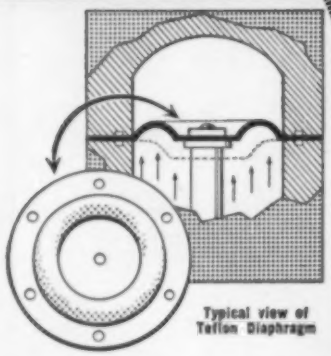

Typical view of Teflon Diaphragm

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BRIEFS continued

operate at variable duct pressures up to 300 psi. Actuating air pressure for the valve is drawn off the upstream side of the valve body, passing through an air passage next to the valve stem and feeds into the air pressure regulator of the actuator. The variable air pressure in the duct is reduced down to a constant 15 pounds pressure needed to operate the

valve. The air also passes through an air filter, made of sintered stainless steel, that will keep sand and dust out of the valve mechanism.

The assemblies are actuated by electrical signals from various types of temperature controls. No relays or limit switches are required, making it possible to eliminate radio noise filters. These electro-pneumatic valve actuators have the advantage of the speed of electrical response, coupled with the power of compressed air.

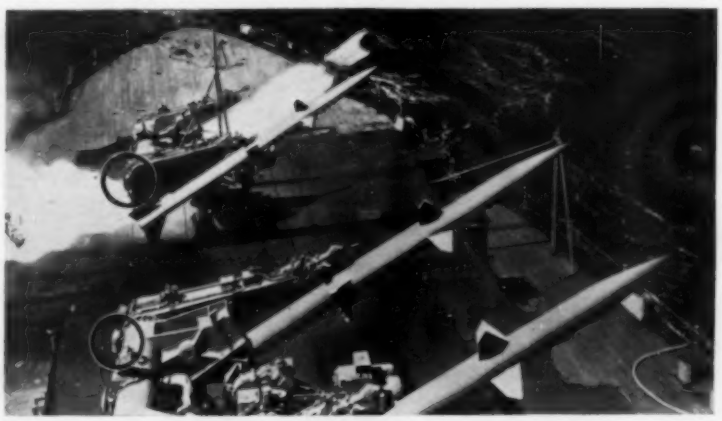
▼▼▼

Design Criteria For Coiled Hydraulic Tubing

Recommendations for the substitution of coiled stainless steel tubing for hose in aircraft hydraulic systems are contained in a report of Air Force sponsored research, released for industry use through the Office of Technical Services, U. S. Department of Commerce. Although coiled tubing has been used by industry in many configurations for hydraulic plumbing, no design criteria existed for prediction of stresses and deformations attainable in any configuration.

Recommended limitations were based on analyses of elements for stresses and deflections caused by mechanical flexure and internal pressure. Fatigue data was gained from a survey of industrial applications, and both straight and curved configurations were an-

Continued on page 56



Hydraulic accumulators are an important part of the control system for launching the Navy's "Terrier", anti-aircraft guided missile. Units are shown mounted at the rear of the firing mechanisms.

How Aeroquip Self-Sealing Couplings Simplify Connection and Disconnection of Fluid Lines

Industrial Type 5100 (wing union nut) or 5110 (hex union nut) for hydraulic fuel, oil, air and water lines.

Farm Type 5203 for hydraulic lines from tractor to farm implements.

Freon Type 5400 for precharging air conditioning lines and components at the factory.

LP-Gas Type 5104 for quick recharging of LP-Gas fuel tanks.

Aircraft Type 145-155 and 3200 for all airframe and engine oil, fuel, hydraulic, and pneumatic lines.

Railroad Type 510022 for quick, safe refueling of diesel locomotives.

Soap testing for leaks is speeded up by using an Aeroquip Self-Sealing Coupling to connect a 240 psi air line to a joint.

Fluid systems requiring frequent disconnection and reconnection can be improved and simplified with Aeroquip Self-Sealing Couplings. One Self-Sealing Coupling performs the same function as two shut-off valves. It occupies less space and speeds fluid line connection and disconnection.

All Aeroquip Self-Sealing Couplings have the following basic characteristics:

a. Quick, easy connection and disconnection of pressurized fluid lines, without loss of fluid or inclusion of air or foreign matter into the system.

b. Full fluid flow through connected coupling; leak-proof sealing of disconnected coupling halves under maximum line pressure.

c. Positive locking action on connection to prevent accidental coupling disconnection and flow shut off.

d. Simple, sturdy design, with sufficient valve strength for long, trouble-free operation.

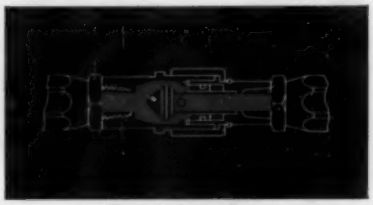
Poppet-Tubular Valve Design

Every Aeroquip Self-Sealing Coupling is designed around mating, spring-loaded poppet and tubular valves. This design principle combines positive sealing action with optimum flow characteristics.

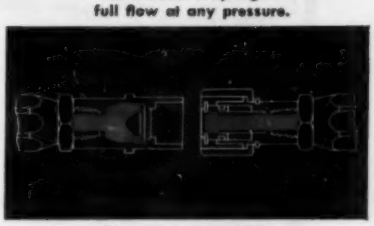
In operation, the poppet valve coupling half mates with the tubular valve coupling half, joined by a quick-threading union nut. Valves open and close simultaneously with the locking and unlocking action of the union nut. Once connected and locked, the coupling cannot unlock accidentally due to vibration and other external forces. Fluid flow through the connected coupling is accomplished with maximum safety and minimum pressure drop.

Many Types Available

No single type Self-Sealing Coupling is ideally suited for the wide range of industrial, aircraft, marine and farm applications. Aeroquip presently manufactures seven types (shown at left) to meet the requirements of varied fluid system use.

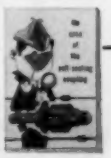


Connected coupling—full flow at any pressure.



Disconnected coupling—halves seal at any pressure.

Full information is available. Fill in and mail the coupon below for your copy of "The Case of the Self-Sealing Coupling" plus engineering bulletins on the coupling types to fit your fluid system needs. See our catalog pages in Sweet's Product Design File, Section 6d.



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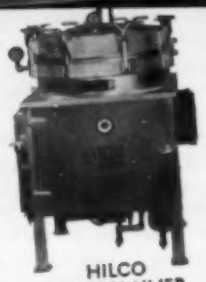

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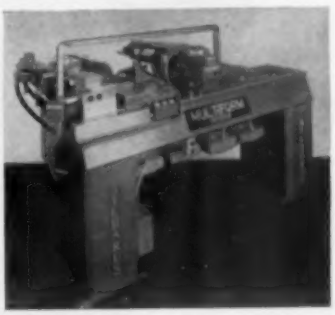
IN CANADA:

BRIEFS continued

alyzed. In addition to the design limitations and description of their derivation, the report contains a motion analysis which should be useful to designers of coiled tubing.

Report PB 121477 Study of Coiled Tubing for Aircraft Hydraulic Systems, may be ordered from OTS, U. S. Department of Commerce, Washington 25. It contains 115 pages, price $3. ▼▼▼



This massive, hydraulically-powered machine can perform double-end bending on any kind or shape of material. Unit shown was designed by J. A. Richards Company to produce multi-angled channels with widths adjustable from 2 to 6 feet. The machine has a 10 hp motor and the automatic production cycle is 15 seconds.

Basic Hydraulics Offered In NCIH Summer Course

A course in basic oil hydraulic power is offered by the NCIH at the Illinois Institute of Technology, Chicago beginning in the second week in June and lasting two weeks. It is a full-time day program, running six hours a day, five days each week.

The course is designed for shop, maintenance, operating, and sales personnel. It consists of lectures, discussions, and laboratory demonstrations and exercises. A class is limited to 25 men, and high school graduation is preferred for admission. The course could be repeated later in the summer in response to sufficient industry demand. ▼▼▼

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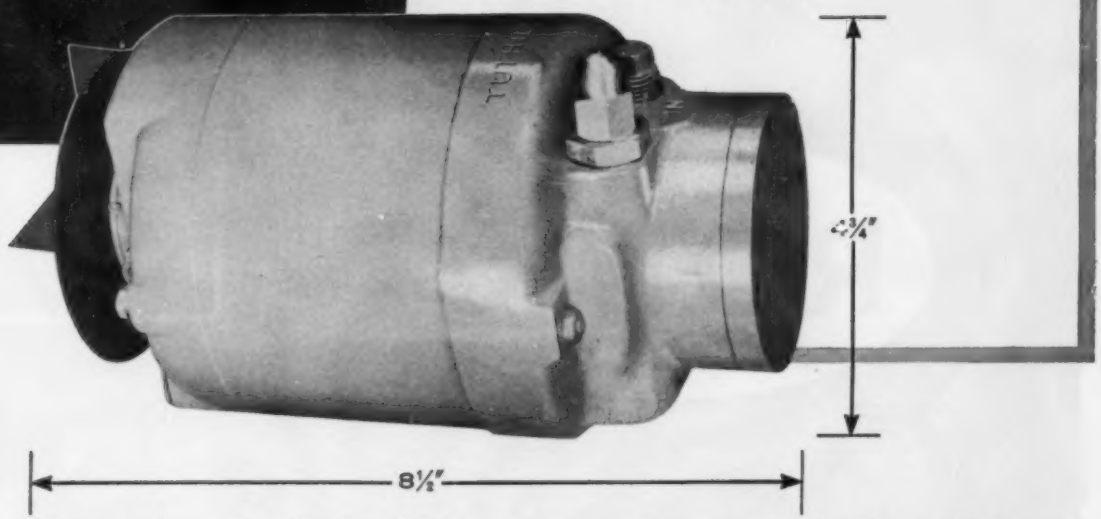

Here's another example of Tuthill's ability to develop the pump to fit the problem. This compact, new Powermite motor-pump combination, a Tuthill exclusive, was developed to meet the requirements of original equipment manufacturers with unusual space and weight limitations.

Motor and cooling blower have, in effect, been incorporated into the internal gear positive displacement rotary pump. The whole unit takes up no more space than a standard electric motor. A single shaft serves all units of the Powermite—and the elimination of couplings, other parts and labor permit substantial economies for OEM applications.

The pump section contains a built-in strainer, and, if desired, an adjustable relief valve. Powermite can be furnished with cooling blower, as illustrated, or it may be supplied with a shaft extension for driving other accessories.

Powermite can be furnished in a wide variety of pump and motor combinations for use in hydraulic, oil burning, lubricating, and other services involving many different fluids. For example, the model illustrated has a capacity of 18 gallons per hour at 300 psi, and is driven by a 1/12 hp motor at a speed of 1750 rpm.

Manufacturers desiring to investigate the cost, space and weight saving advantages of incorporating Powermites into their products are invited to submit detailed specifications. Or, if preferred, a Tuthill representative will call.

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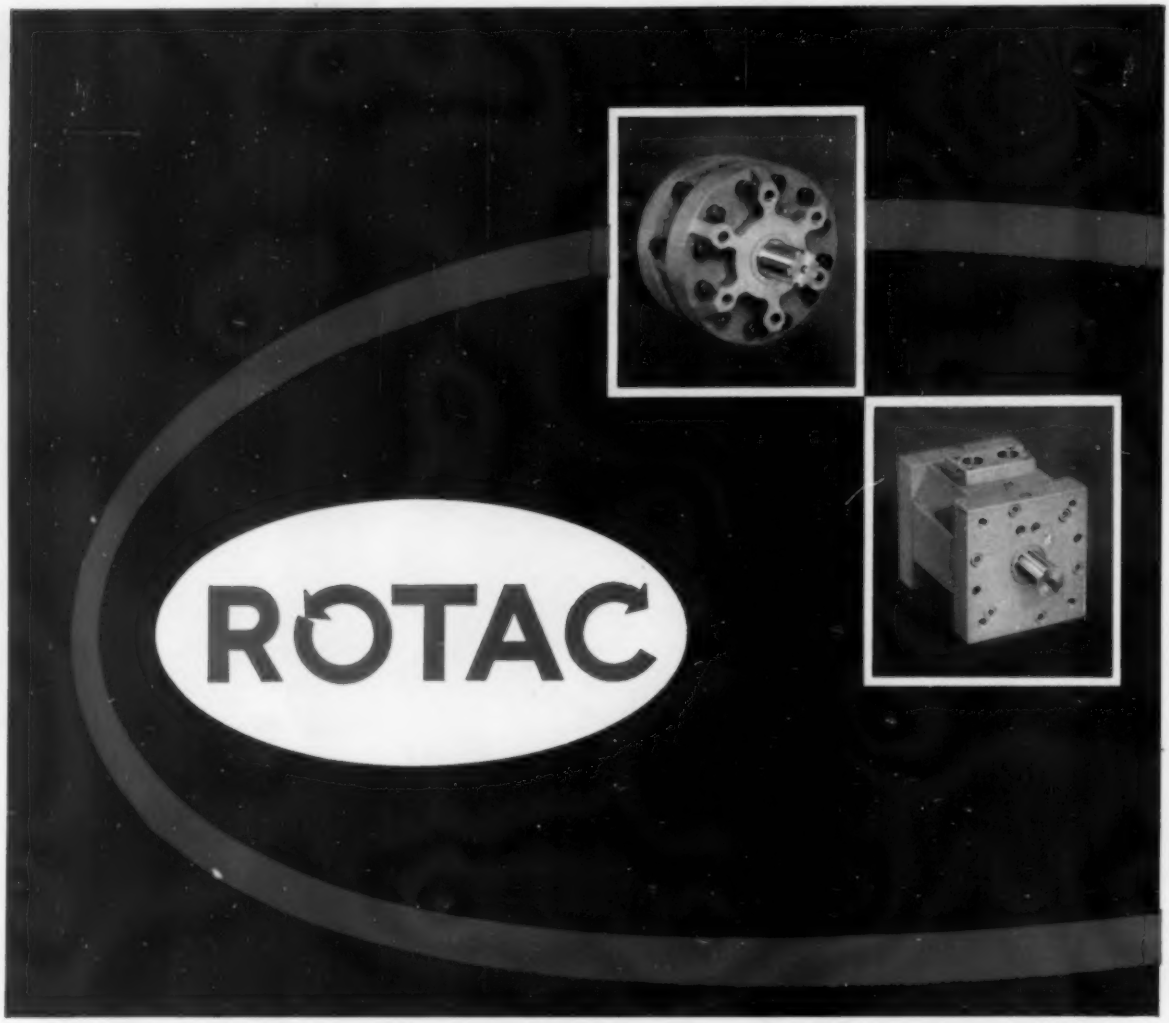

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Rōtac has undergone improvements in design, performs many jobs better than ever before. But more important, behind every Rōtac stands—not just the name—but the reputation of Ex-Cell-O. You'll recognize the familiar precision and craftsmanship that has gone into every Ex-Cell-O product for nearly forty years. You've seen it in hydraulic power units, machine tools, precision spindles, aircraft parts, bushings and Continental cutting tools made by Ex-Cell-O.

Yes, Rōtac is a new name in reciprocating torque actuators but you *know* the reputation!

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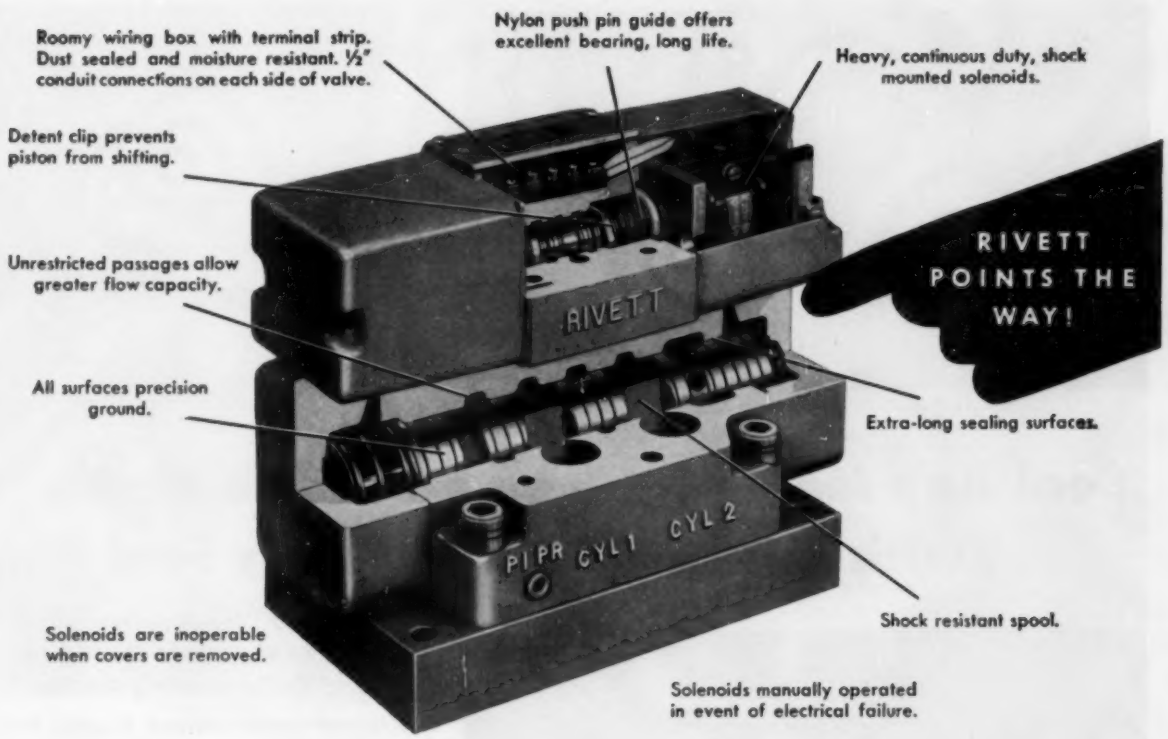
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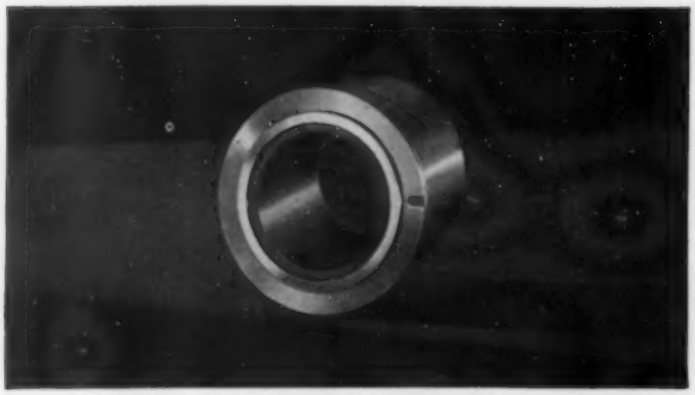

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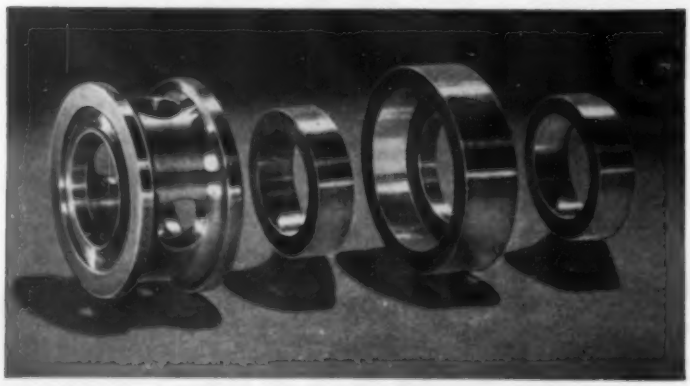
Seal Any Medium—Even Corrosive Media ... with Koppers Floating Ring Seal

MULTIPLE RING TYPE Floating Ring Seal (assembled)



FLOATING RING SEAL Basic Elements: Lantern Ring, Floating Ring, and Spacer Diaphragm. As sealing needs dictate, floating rings and spacer diaphragms are added. Seals are carbon, plastics, ceramics or steel, as applications require.

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Koppers' precise, efficient Floating Ring Seal assures long seal life, low leakage, reduced wear, less power consumption, and decreased operating costs.

It seals at high temperatures and at pressures up to, and for some conditions even above, 2000 psi. Inspection has shown that after 10,000 hours of operation, ring and spindle wear can be negligible. For water at 500° F. and 1200 psig with a ⅝" spindle, leakage is only one to two pounds per hour. Frictional power requirements are virtually zero, and Koppers' design reduces radial frictional restraint. Sealing members adapt to changes in the shaft's position.

Applicable to valve spindles, pumps, atomic reactor spindles and many other similar installations, Koppers Floating Ring Seal gives efficient, low-cost service for the sealing of all types of fluids under widely varying conditions of temperature and pressure.

For additional information, write to: KOPPERS COMPANY, INC., Piston Ring and Seal Department, 1505 Hamburg Street, Baltimore 3, Maryland.

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use VALVAIR'S HI-SPEED INLINE VALVES

for instant-action control of clutches and brakes!

The split-second response of Valvair's pilot-operated HI-SPEED INLINE valves means shorter machine cycle time . . . more work per hour . . . more accurate cuts for high speed cut-offs . . . less clutch and brake slip . . . lower maintenance costs! And, precise control cuts machine set-up time . . . assures safer operation by minimizing drift.

Short travel, air cushioned poppet action is the HI-SPEED INLINE'S speed secret. Simple design assures multi-million cycle dependability . . . the valve has only 3 moving parts!

Built to Valvair's high standards, the HI-SPEED INLINE features cast Navy M bronze bodies, pilots built to JIC standards and fully interchangeable with your Speed Kings, solenoid coils guaranteed against burn-out for the life of the valve, plus molded Hycar poppet seals. Manual over-ride and integral junction boxes optional.

Valvair HI-SPEED INLINES *are available for immediate delivery from stock*, in sizes and types for every need. Specify them on new equipment . . . use them to replace obsolete valves now in service . . . one installation will convince you! Valvair Corporation, 454 Morgan Ave., Akron 11, Ohio.

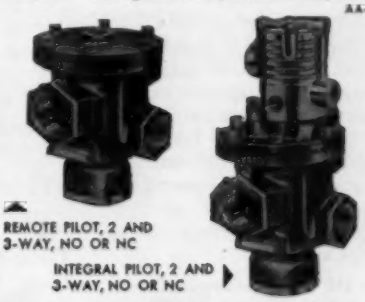
AA-8250

Find your nearest representative in the 'Yellow Pages'

Compare . . . and you'll buy

Valvair

Sizes range from ¼ to 1½ in. NFT. Solenoid pilot coils for ac or dc, any voltage. Working pressure, 10 to 200 psi.



REMOTE PILOT, 2 AND 3-WAY, NO OR NC

INTEGRAL PILOT, 2 AND 3-WAY, NO OR NC

Representatives in: Baltimore • Birmingham • Boston • Buffalo • Charleston, W. Va. • Chicago Cleveland • Cranford, N. J. • Dayton • Denver • Detroit • Eureka, Calif. • Grand Rapids Houston • Indianapolis • Kansas City, Mo. • Logansport, Ind. • Los Angeles • Louisville • Miami Milwaukee • Minneapolis • Muncie • New Orleans • New York • S. Pasadena • Philadelphia Pittsburgh • Portland, Ore. • St. Louis • Seattle • San Francisco • Syracuse • Montreal • Toronto Vancouver

Useful Literature

For your free copy of publications reviewed, fill in the reader service card

AIR LINE FILTERS . . . for all air-operated tools and machines, are produced by Briggs Filtration Co., Washington, D. C. Available bulletin describes the units, giving specifications, physical characteristics and air-flow rates at specific pressures. Filter cartridges and cases are designed so that all air first passes through a fuller's earth block to remove water, oil and minute solid particles. Large sump permits draining once daily under normal conditions.

Circle 250 on Reader Service Card

AIR & OIL VALVES . . . for all types of fluid power applications, are presented in Bulletin MCA 107 issued by M. C. Mfg. Co., Lake Orion, Mich. Valves listed include relief, manual control, pressure-actuated control, solenoid, transfer and shuttle, pressure-reducing, check and restrictor and brake valves. The line also covers dehydrators and compressors. Complete engineering information and specifications are given for the models available.

Circle 251 on Reader Service Card

HYDRAULIC CYLINDERS . . . engineered for maximum power in a minimum space, are manufactured by The Sheffer Corporation, Cincinnati, Ohio. Bulletin C4H gives complete engineering information and specifications on units for 2000 to 3000 psi, in bore sizes 1-½ to 12 in. Cylinders meet all JIC standards and feature all-steel construction. Folder gives schematic drawings showing various mountings and rod-end styles available.

Circle 252 on Reader Service Card

TUBE FITTING ADAPTORS . . . manufactured for hydraulic service by Parker Appliance Company's Tube & Hose Fittings Division, are detailed in Catalog 4360. Technical details and specifications are given on their dryseal type pipe fittings and straight thread plugs, locknuts and O-Rings.

Circle 253 on Reader Service Card

HOSE COUPLINGS . . . hose and hose assemblies for all types of hydraulic and pneumatic applications are produced by Perfecting Service Co., Charlotte, N. C. Bulletin 1475 gives complete engineering information and specifications with illustrations of various units and applications. Line includes quick-connect and disconnect double shut-off and straight-through couplings; hose fittings and adaptors; hose; ferrules and crimping tools and rotary-union air seals.

Circle 254 on Reader Service Card

TEFLON HOSE . . . and hose assemblies, with leak-free, blowoff-proof, compression fittings, are available from Flex-O-Tube Div. of Flexonics Corp. Brochure gives technical data and specifications on the various types available. Materials resist swelling and corrosion, have a smaller OD for lightweight and space-saving, are chemical-proof and withstand heat to 450 F.

Circle 255 on Reader Service Card

HYDRAULIC TRANSMISSION . . . featuring Gerotor variable-speed unit, is presented in Catalog T-100-A published by Gerotor May Corp., Owings Mills, Md. Transmission features infinitely variable speeds to 1500 rpm without gearing, constant or variable torque and horsepower and smooth braking, instantaneous or delayed. Folder gives complete information on this type of transmission, along with performance charts and cross-sectional drawings. Also included are problems and solutions showing flexibility of the transmission, and illustrations and information on applications.

Circle 256 on Reader Service Card

SELF-SEALING PIPE FITTING . . . produced by Tru-Seal Division of Flick-Reedy Corp., is described in a 4-page brochure. Fitting stops leaks in old and new pipe circuits without use of conventional sealing compounds. Self-sealing is achieved by a thin, nut-like fitting with a dry, milkly-white, Teflon plastic insert. The device is simply screwed on, and, after assembly tightened against a fitting with light torque. Bulletin offers two special trial assortments of fittings designed to stop leaks permanently at pipe connections. Brochure contains complete dimensional and installation data.

Circle 257 on Reader Service Card

FLUID POWER DEVICES . . . manufactured by Modernair Corp., San Leandro, Calif., are covered in a concise, 4-page bulletin. Line includes air and hydraulic cylinders and valves, and package units such as air controls, air-operated collet-holding fixture, air compressors and portable hydraulic pumping unit. All items are illustrated and briefly described.

Circle 258 on Reader Service Card

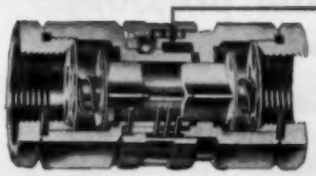
For more reviews of FREE LITERATURE turn to page 180

WHICH SNAP-TITE QUICK-CONNECT COUPLING IS BEST FOR YOU?

SNAP-TITE "H" COUPLING . . . . . FOR HIGH PRESSURE APPLICATIONS

FOR HYDRAULIC OR AIR

"H" Coupling for high strength, higher efficiency, high-resistance to heavy line surge. Sizes: ⅛" thru 12". Bulletin No. 240

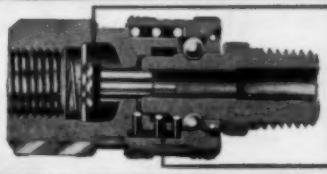


Exclusive U-packer gives a positive seal without compression set because of rubber distortion. Line pressure inside the U-packer keeps it open and forced against its metal backing—the higher the pressure, the tighter the seal.

SNAP-TITE HI-FLOW COUPLING . . . FOR LOW PRESSURE APPLICATIONS

FOR AIR AND FLUIDS UP TO 150 p.s.i.

Hi-Flow is recommended to connect small air tools to plant air system, and for low pressure fluid transfer in small lines. Sizes: ⅛" thru ¾". Bulletin No. 230

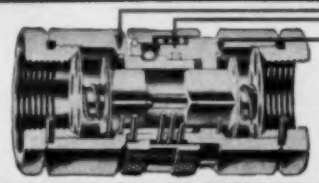


Bonded valve washer
(pat. pending on valve construction)

Exclusive U-packer

SNAP-TITE "HK" COUPLING . . . . . FOR HARD TO HANDLE FLUIDS

FOR FUMING ACIDS, ALKALIES, SOLVENTS, AND HIGH PRESSURE STEAM . . . "HK" is the only coupling now on the market for fluid temperatures from —100° F to +500° F . . . and for live steam up to 460° F. Its seals are made of Teflon for which there is no known solvent. Sizes: ½" thru 3". Bulletin No. 270



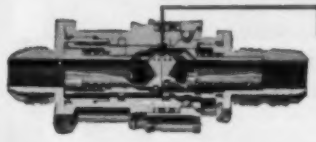
Teflon Valve Seal

Teflon Nipple Seal

Teflon Valve Seal

SNAP-TITE NO-SPILL COUPLING . . . FOR MINIMUM AIR INCLUSION

FOR AIRCRAFT, MISSILE HYDRAULIC, FUEL SYSTEMS which cannot stand air in the lines, and for transmitting fluids which *must not spill*, the Snap-Tite no-spill coupling is recommended. Bulletin No. 280

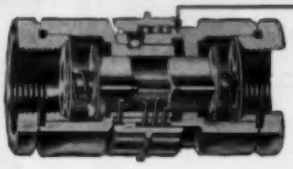


Flush valves prevent spillage, air inclusion. Snap-Tite will engineer special variations to your requirements.

SNAP-TITE "E" COUPLING . . . . . FOR VACUUM and VERY LOW PRESSURE

FOR VACUUM SYSTEMS IN THE MICRON RANGE

"E" Coupling performs in the *micron* range in the smaller sizes both connected and disconnected. Recommended, too, for gravity flow . . . U.L. approved for LP Gas. Sizes: ⅛" thru 12". Bulletin No. 250



Nipple seals in coupler by depressing the lip of the E packer and slightly compressing the body of the packer. This new E-packer gives positive seal under high-pressure, low-pressure, and vacuum.

Snap-Tite Couplings are available plain, (without valves), and with either single or double shut-off. Couplings normally furnished in alloy steel, but all (except hi-flow) are also available in brass, aluminum, or stainless steel with a variety of finishes.

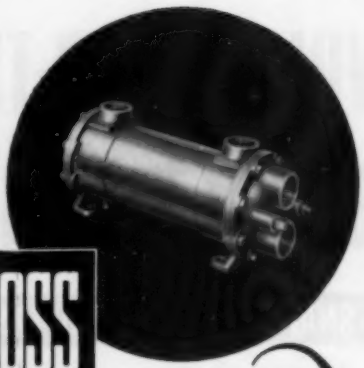
Snap-Tite

SNAP-TITE COUPLINGS CAN HANDLE ALMOST ANYTHING THAT FLOWS

SNAP-TITE, INC., UNION CITY 1, PA.

With a Ross Exchanger on the job...

Bliss Hydro-Dynamic Press keeps cool under pressure



ROSS

Performing hot gabbaging and piercing operations in the manufacture of 105 mm projectiles, this 500 ton Bliss Hydro-Dynamic Press functions with accurate and consistent hydraulic pressures.

Rated power is insured by a factory installed Ross Exchanger, furnished to hold hydraulic temperatures in check *at all times*. Pump slippage from over-heated, thinned oil is effectively prevented, thereby assuring uniform pressures of known intensity.

Ruggedly built to withstand punishing hydraulic shock, Ross Exchangers are regularly chosen for numerous types of hydraulic equipment: die casters, metal drawing presses, plastic molders, extrusion presses, fluid drives, welders, stretch-wrap formers, and many others.

Completely pre-engineered and fully standardized, these compact units are available in a wide range of sizes to meet your heat transfer requirements.

For detailed information request Bulletin 1.1K5. Ross Heat Exchanger Division of American-Standard, Buffalo 5, N. Y. In Canada: American-Standard Products (Canada) Limited, Toronto 5, Ont.

ROSS HEAT EXCHANGER

Division of American-Standard

Manufacturers of Automatic Controls for Home, Industry, and the Military

You're covered across the board

when you use
General Controls' line of quality automatic controls

In heating, power generation or process regulation – whenever automatic controls are needed – plant engineers everywhere have found that it pays to check *first* with General Controls. General Controls' comprehensive line ranges from the simplest time switch or thermostat to advanced programmers and recording controllers. And you're never very far from one of 40 helpful branches (located coast to coast), where General Controls' experienced representatives are always at your service. Give your local General Controls field representative a call on your next control problem.

K-21 MAGNETIC STOP VALVE

Packless—2 way—normally closed. For air, gas, steam, water, oil, corrosive fluids. Pressures to 300 psi. Forged brass body. Stainless steel or soft seat.

K-27 MAGNETIC VALVE

Stainless steel for high sulphur fuels, syrups, juices, acids, alkalis, etc. Pressures to 300 psi. Midget size. Multi poised—operates in any position.

K-10 MAGNETIC VALVE

Lever action for higher seating pressure. Excellent general purpose valve for primary fuel, feed water, steam, air. (300 psi max. operating pressure differential.)

K-15 MAGNETIC VALVE

Piloted piston design. Large flow capacity with low pressure drop. For air, gas, steam, oil derivatives. Versatile—with 3 coil classes, 5 seat variations.

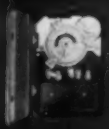
K-123 MAGNETIC VALVE

3 way—for normally open or normally closed directional control and mixer applications—on pneumatic or hydraulic operated devices, machine tools, etc.

K-273 MAGNETIC VALVE

3 way flow or mixer type. Compact, multi poised. For air, water, hydraulic fluids—charging or emptying systems. Normally open or closed. Choice of flow patterns.

TIME SWITCHES



Wide selection for domestic and commercial use—spring wound or motor driven, normally open or closed. For ventilating, lighting, refrigeration, etc.

HYDRAMOTORS

Wide range of types in complete range of pipe sizes and body styles to provide safe, dependable, durable answer to all liquid transfer problems.

AIR MOTOR VALVES

Air-operated diaphragm valve for modulating control. Normally open or closed, 3 way, or slide gates. Selection of various inner valves, body sizes and connections.

General Controls
Automatic
Control Line

Five Plants:
Iron Mountain, Michigan
Glendale, California
Burbank, California
Skokie, Illinois
Guelph, Canada

GENERAL CONTROLS

FORTY BRANCH OFFICES SERVING THE UNITED STATES AND CANADA

Circle 60 on Reader Service Card

TUBEXPERIENCE IN ACTION

In equipment from machine tools to harvesters,

Superior TUBING ASSURES A

More and more manufacturers are specifying bright, clean, smooth Superior tubing for their hydraulic lines—and getting dependable leakproof systems. Here's why—

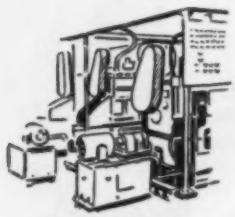
- *Offered in 156 different sizes*
- *Offered cut, multiple, straight or coiled*
- *Every length 100% hydrostatically tested*
- *Made from non-aging steel*
- *High resistance to fatigue failure*
- *Can be bent and flared easily*
- *Shipped with rust-preventive coating*
- *Produced to rigid quality standards*

Your nearest Superior warehouse distributor can give you prompt service and expert advice on tubing problems. Call him today.

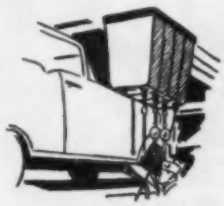
If you manufacture or repair equipment using hydraulic lines, it will pay you to look first at the many advantages Superior (SAE) hydraulic tubing offers you. Some sizes can bear working pressures as high as 12,000 psi. It is non-aging steel with maximum carbon content of only 0.12%. This gives high ductility, which permits easy bending and flaring. We furnish it in dead-soft annealed temper, in cut, multiple or random straight lengths up to 30 ft.—or longer in coiled form.

DEPENDABLE HYDRAULIC SYSTEM

Typical end products which use Superior (SAE) hydraulic tubing



MACHINE TOOLS

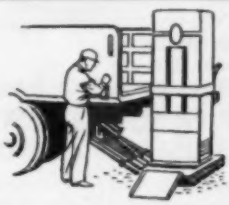


GREASE GUN LINES

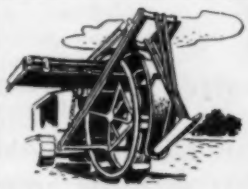
MATERIALS HANDLING EQUIPMENT

OIL WELL DRILLING EQUIPMENT

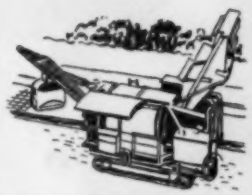
AIRCRAFT HYDRAULIC LINES



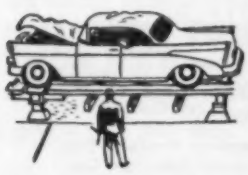
HYDRAULIC TAILGATES ON TRUCKS



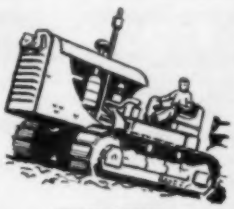
DITCHDIGGERS



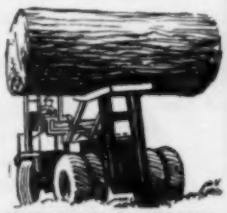
HIGHWAY CEMENT MIXERS



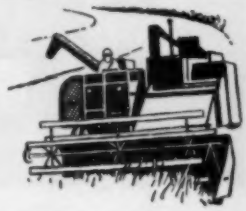
WHEEL & FRAME STRAIGHTENING EQUIPMENT



BULLDOZERS



HYDRAULIC LUMBERING LIFT TRUCK



HARVESTING EQUIPMENT

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to ⅜ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast:
Pacific Tube Company • 5710 Smithway St., Los Angeles 22, Calif. • RAymond 3-1331

SUPERIOR TUBE COMPANY
2030 Germantown Ave.
Norristown, Pa.

I want technical data on Superior (SAE) hydraulic tubing. Rush me my copy of Bulletin 39 and the reprint article "Selecting and Installing Hydraulic Tubing."

*Name*_____ *Title*_____

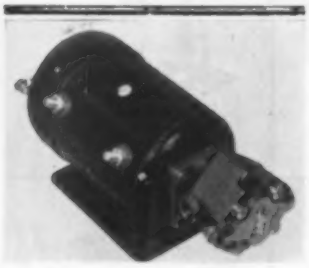
*Company*_____

*Address*_____

New Products

Components, tools and equipment for fluid power systems. For more information fill in and mail post card bound in this issue.

MOTOR-PUMP COMBINATION . . . designed for mobile equipment



Features: Unit is designed for all six and 12-volt, battery-operated applications, such as vehicles, lift trucks, snow plows, tail gate lifts and graders. Combination is compact, measuring only 12-⅜ in. in length, and includes a four-bolt foot mounting integral with the motor for ease of installation in crowded locations. Direct coupling eliminates alignment problems between pump and motor, and any need for external flexible couplings. Pumps with greater or smaller capacities can be substituted without changing the mounting.

Specifications: Nylon check and relief valves assure leakproof operation and long life. Specially constructed heavy-duty dc series motor provides high starting torque. Motor-pump combination can be supplied with stationary or removable brushes.

Webster Electric Co.
Racine, Wis.

Circle 210 on Reader Service Card

FOUR-WAY VALVES . . . have quick-dump action

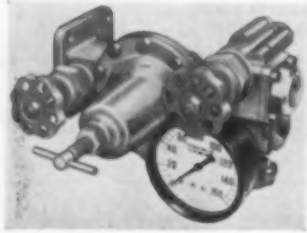
Design: Valves are four-way, five-port type, with no internal springs, packings, pistons, or sliding metal-to-metal contacts. Action is ultra-fast and positive, giving smooth flow, dead-seal closing, extra large capacity and long service life.

Features: Two of the valves are electrically operated and the third is equipped with a hand lever. The electric valves do not employ solenoids, but instead use electro-magnetic armatures. Armature travel in actuating the valve is only .022 in. This short throw eliminates hammering action and reduces wear. One of the units is a momentary impulse type. A single electric impulse opens one valve section and closes the other. Valve stays in this position until a second impulse returns it to the opposite position. No current is required to hold in either position.

Humphrey Products Div.
General Gas Light Co.
Kalamazoo, Mich.

Circle 211 on Reader Service Card

AIR CONTROL MANIFOLD . . . groups several valves



Features: Units are designed to combine many of the controls required in air-pressure applications and eliminate many separate connections. In the cast aluminum body are combined pressure-reducing regulator, shut-off valve, strainer, blowdown valve, check valve, pressure gage, and pressure gage snubber. Both installation time and original cost are reduced because of the number of units combined in one body. Headers with two to eight stations permit installation of many controls in one location. Units are readily interchangeable because of sub-plate mounting, and when maintenance is required, the defective part is easily removed for servicing and another installed in its place. Units should be suitable for many applications where air pressure must be regulated and controlled.

Republic Mfg. Co.
Cleveland, Ohio

Circle 212 on Reader Service Card

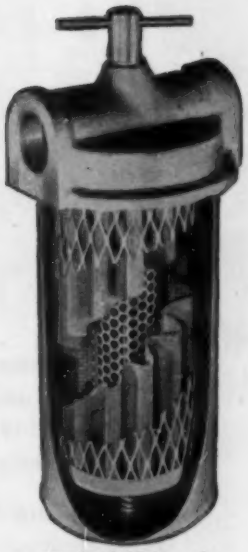
Continued on page 74

Simplify Your Preventive Maintenance

SUMP TYPE (Cutaway)

with

MARVEL SYNCLINAL FILTERS



LINE TYPE (Cutaway)

For All Hydraulic and Other Low Pressure Liquid Systems

SIMPLE, EFFICIENT DESIGN

REDUCES DEMAND ON YOUR SKILLED MAINTENANCE HELP

ANY WORKMAN can disassemble, clean and reassemble Marvel Synclinal Filters. Cleaning is done quickly, and Marvel's extra capacity requires less frequent cleanings. This means more production per machine with less man hours. Marvel protected machines spend their time producing, not in being serviced and repaired. Marvel's BALANCED Synclinal Design and simple efficiency changes down-time to producing time.

STANDARDIZE WITH MARVELS

Choice Of OVER 750 Original Equipment Manufacturers

Improve your all-important preventive maintenance by simplifying it. Use Marvel Synclinal Filters throughout our plant. Specify Marvel on new machines, add Marvel to present machines. No moving parts to wear, nothing to keep in stock. Your first cost is your only cost.

A SIZE FOR EVERY NEED

Available for sump or line installation in capacities from 5 to 100 G. P. M. Greater capacities may be attained by multiple installation (as described in catalog). Choice of monel mesh sizes range from coarse 30 to fine 200.

WATER FILTERS

Both sump and line type filters have been adapted for use in all water filtering applications. No changes have been made in the basic, balanced synclinal design.

IMMEDIATE DELIVERY!

As in the past, Marvel continues to offer Immediate Delivery

FILTERS FOR FIRE-RESISTANT HYDRAULIC FLUIDS

Marvels most recent development is a filter for the efficient filtration of all types of fire-resistant hydraulic fluids.

Catalogs containing complete data available on request

MARVEL ENGINEERING COMPANY

7227 N. Hamlin Ave., Chicago 45, Ill. **PHONE: Juniper 8-6023**

Without obligation, please send me complete data on Marvel Synclinal Filters, as indicated: (AH-5)

- ☐ Catalog #107—For Hydraulic Oils, Coolants, Lubricants.
- ☐ Catalog #200—For Fire-resistant Hydraulic Fluids (Aqueous Base)
- ☐ Catalog #400—For Fire-resistant Hydraulic Fluids (Synthetic)
- ☐ Catalog #301—For Water

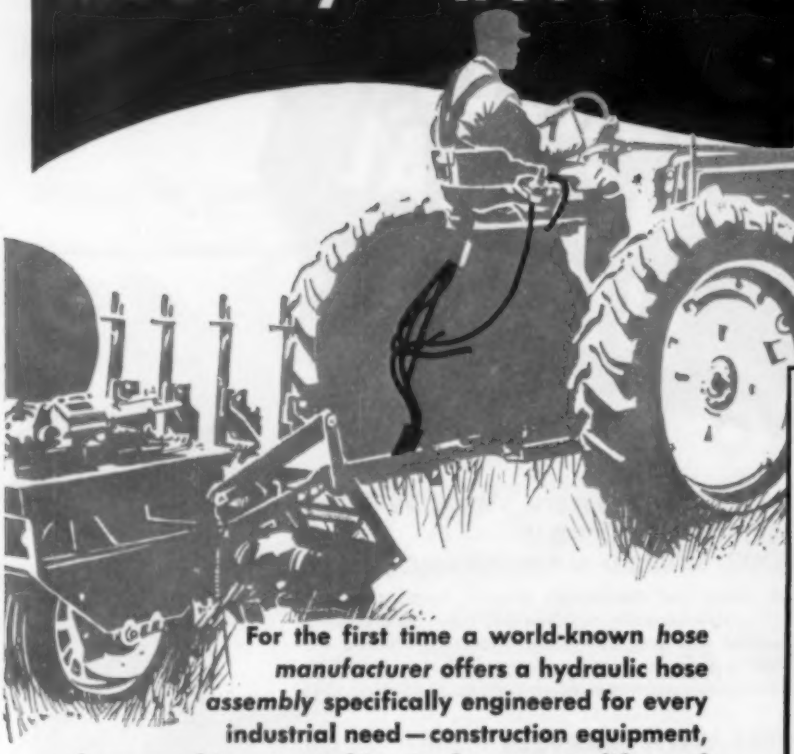
Name _____ Title _____

Company _____

Address _____

City _____ State _____

Now... hydraulic assemblies made by a *hose* manufacturer



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1. Gates is able to offer *over-all* quality control.
2. Gates, with a nation-wide engineering and service organization of its own, is in a *unique* position to advise, assist and supply manufacturers of machines, vehicles and equipment which use hydraulic systems.

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Denver, Colorado

Gates High Pressure Hydraulic Hose (54MB) meets or exceeds SAE specifications

This smooth-covered, easy-to-keep-clean hose has reinforcing braid of extremely flexible high-tensile wire, made specially for this use. Black, oil-resistant rubber withstands heat, abrasion and weather exposure. Recommended for systems subjected to shock loads and heavy pulsating pressures.

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Same quality construction, but with braided cord reinforcement—more than adequate for the lower pressure applications.

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TPA 193

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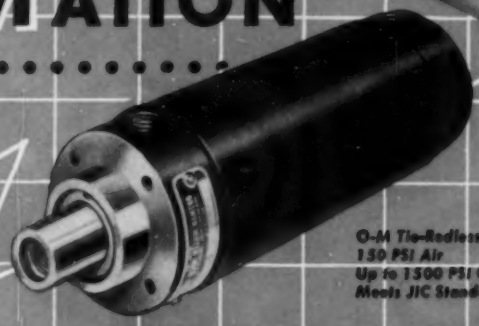

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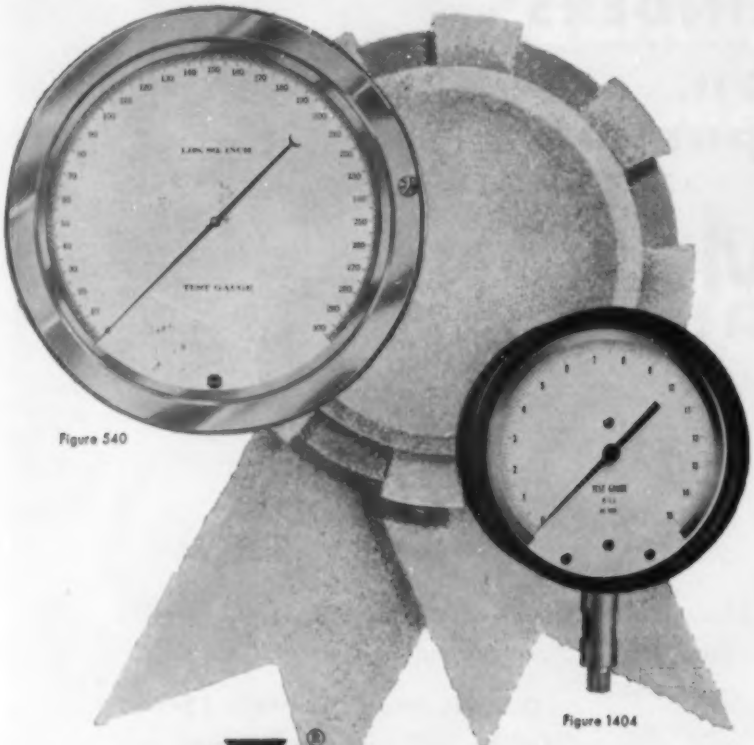

Figure 540

Figure 1404

in these USG TEST GAUGES

The new 1400 Series gauges have a wide range of applications . . . for test cells and panels . . . for portable testers . . . for checking and calibrating gauges in service . . . for laboratory work not requiring readability of 12" or 16" gauges.

Available in 4½", 6" and 8½" dial sizes with ranges from 30" Hg. Vacuum to 5000 psi, for stem (Fig. 1404), wall (Fig. 1400T), or panel (Fig. 1402) mounting.

Accuracy—¼ of 1% of scale guaranteed.

Laboratory Test Gauges Fig. 540—12" and 16"—have long been recognized as the master calibration standard. Because of their precision, they are frequently used to replace or augment dead weight testers or manometers.

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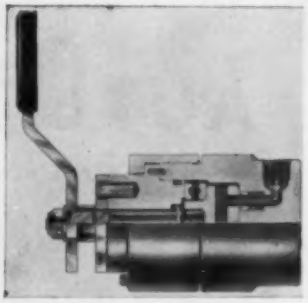
New Products / continued

10,000 PSI VALVE
. . . uses shear-seal

Specifications: Designed for high-pressure hydraulic or pneumatic service, this shut-off valve uses the shear-seal principle. Unit handles



pressures of 10,000 psi and withstands surge pressures up to 15,000 psi without damage to the valve. It is designed for a burst pressure of 40,000 psi. Furnished for pipe, tube, AND 150, or any special high-pressure connection.

Barksdale Valves
Los Angeles, Calif.

Circle 213 on Reader Service Card

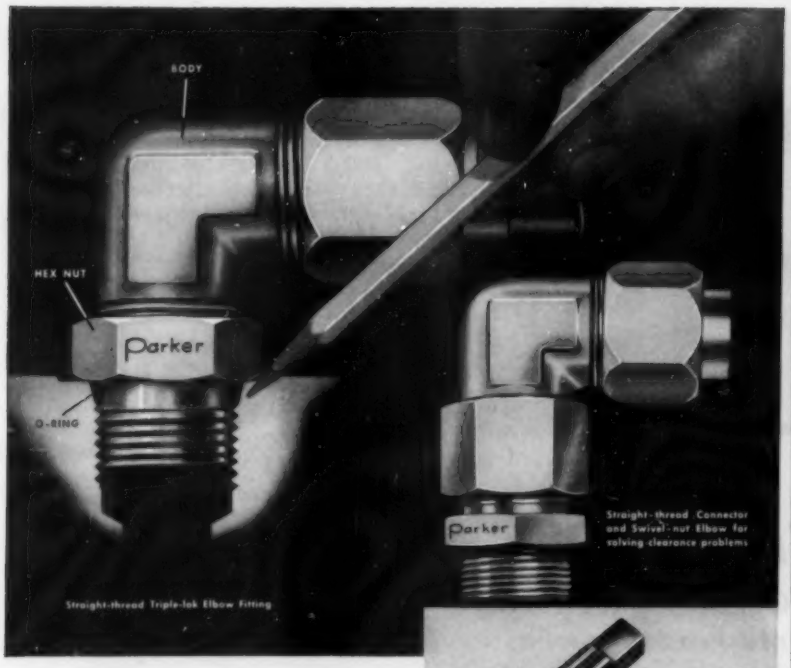
FLEXIBLE COUPLING
. . . uses cushion compression

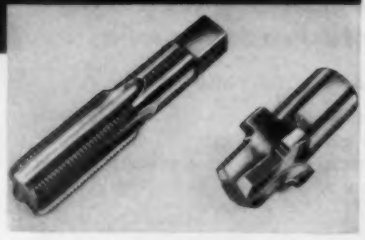
Designation: Type L-093

Features: Installation, removal, assembly or disassembly can be quickly and easily accomplished, since the coupling consists simply of two

bodies with jaws and a one-piece, spider-type cushion. The load is transmitted by cushion compression, so the metal jaws are not subjected to wear. Lubrication is never required. Dirt, water or similar adverse conditions have no affect on performance. The cushion spiders out into six load ends which are in plain sight for quick inspection. On non-reversing loads, only three of

Continued on page 76





Precision thread-tapping and counterboring tools for making accurate *straight*-thread boss (to receive these new Parker *straight*-thread fittings) are now available with machining drawings from Parker.

New Parker *straight*-thread fittings solve your leakage problems

Now you can forget about high-pressure hydraulic problems resulting from tapered pipe threads. Forget about leakage . . . about the danger of cracking or distorting valve bodies by over-tightening the fittings . . . about damaged threads from over-tightening to obtain proper positioning. Forget about messy pipe "dope".

You can eliminate all of these problems by using new Parker *straight*-thread fittings with positive O-ring seals. (See illustration above.)

Parker *straight*-thread fittings are now being supplied in response to the growing demand for this new type of leakproof, trouble-free connection. They are shorter and have smaller hexes than the AN fitting for the old AND 10050 boss. *Straight* threads are available on *Triple-lok* (the industrial standard flare tube fitting) and on *Ferulok* (flareless fitting for heavy steel tubing).

This is another example of Parker's pioneering leadership in the field of hydraulic fittings. Write for Catalog.

TUBE AND HOSE FITTINGS DIVISION
Section 417
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio

Parker
Hydraulic and fluid system components

Now enjoy advantages of rubber-covered hose without stripping . . .

Use new Parker NO-SKIVE fittings

Stop stripping hose covers! New NO-SKIVE *Hoze-lok* fittings require no stripping of rubber-covered hydraulic hose. They're faster, easier-to-use . . . *and re-usable.*

Two simple steps complete the make-up: (1) Dip end of hose in oil and screw into socket counter-clockwise until hose reaches end of recess in socket. (2) Dip nipple in oil and push into socket and hose, turning clockwise to engage thread. Screw all the way in.

During step (1), the lead thread of the socket cuts through the rubber cover of the hose. This permits the threads following it to contact and grip the wire braid. It will hold beyond hose-bursting pressures . . . also under severe vibration conditions.

Send for Bulletin 4433. Mail the coupon for complete information about these new Parker *Hoze-lok* fittings. Find out how you can simplify and speed your hose assemblies.

TUBE & HOSE FITTINGS DIVISION
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New Products / continued

the load ends are under compression, while the other three are idling. Thus, the cushion can be reversed for double service life.

Specifications: Ratings range from 0.4 hp at 100 rpm to 4.6 hp at 3600 rpm. OD is 2-⅛ in., overall length 2-½ in. Bores run from $\frac{5}{16}$ to 1 in. in $\frac{1}{16}$ in. increments.

Lovejoy Flexible Coupling Co.
Chicago, Ill.

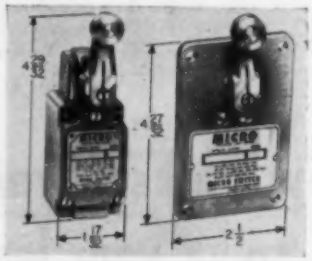
Circle 214 on Reader Service Card

TWO-CIRCUIT LIMIT SWITCHES

. . . are shock resistant

Designation: 1LS1 and 7LS1

Features: Units have been redesigned to provide them with forged aluminum-alloy, roller-arm actuators and a higher electrical rating. The sealed construction, higher electrical rating, and stronger aluminum actuators make these small switches suitable for fluid power



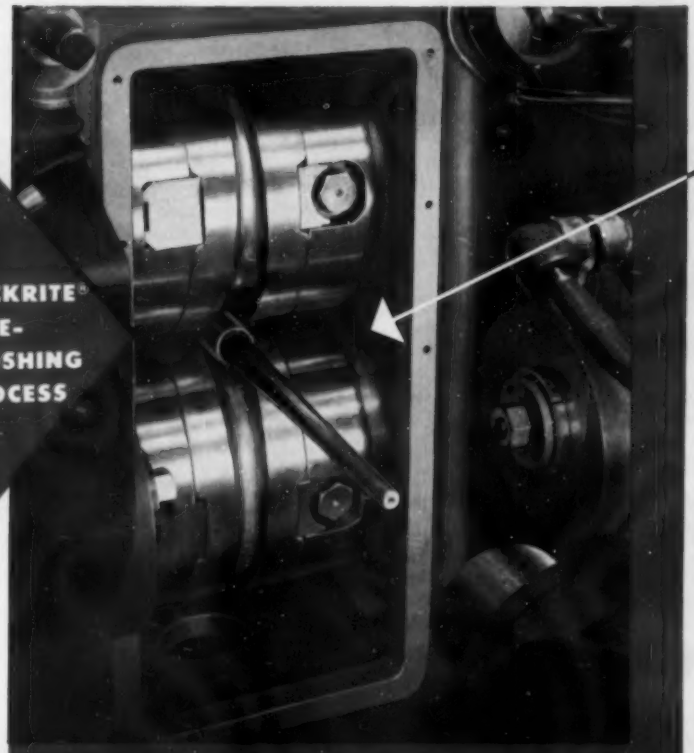
applications where restricted space is a prime factor in switch selection.

Specifications: Model 1LS1 is the standard unit, and 7LS1 is flush-mounted. Actuators can be field adjusted through 360 degrees and positively locked in any position. The 1LS1 has an adjustable head assembly for mounting in any of four directions. Electrical ratings have been increased to: 10 amp. 120, 240, 480 v ac; ½ hp 120 v ac; 1 hp 240 v ac; 0.8 amp. 115 v dc; 0.4 amp. 230 v dc; 0.1 amp. 550 v dc. Pilot duty rating is 600 v ac maximum.

Micro Switch Div. of
Minneapolis-Honeywell Regulator Co.
Freeport, Ill.

Circle 215 on Reader Service Card

For more NEW PRODUCT reviews turn to page 170



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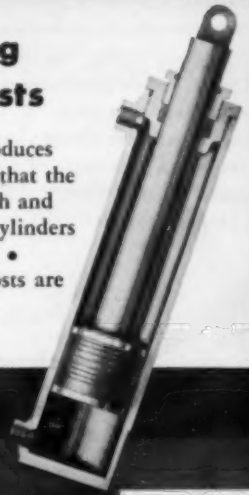
Rockdrawn® Quality Hydraulic-Line Tubing

Rockrite high surface finish tubes are precision cold drawn to produce Rockdrawn small-diameter tubing that is consistently of the highest quality.

Cylinder Tubing cuts honing costs

The Rockrite process produces such a high surface finish that the tubing can be cut to length and used as is for hydraulic cylinders with soft-packed pistons. • Machining and honing costs are always cut to a minimum.



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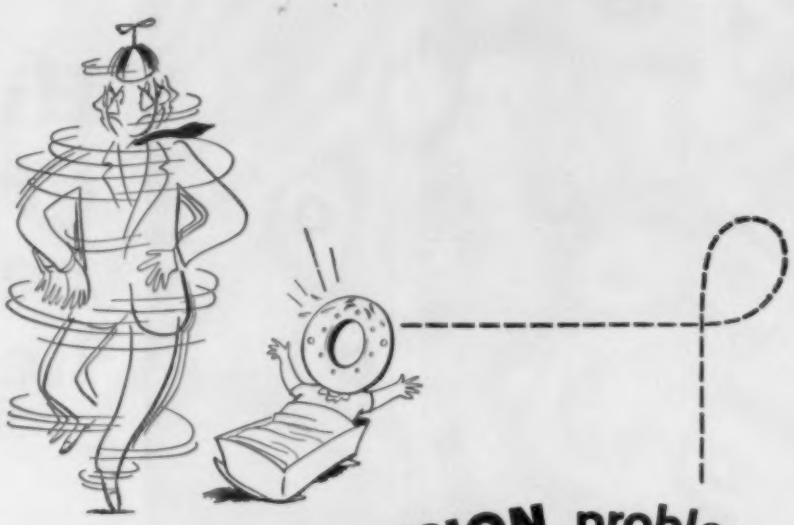

a FRETTING-CORROSION problem had him in a spin

Finding a wear-resistant coating for turbine engine shaft seals posed a serious problem for an aircraft engine manufacturer. Even the hardest alloys were subject to fretting corrosion and had to be replaced after a few hours of service.

This fretting-corrosion problem was solved by having the bearing surface of the seal Flame-Plated by LINDE. By this special detonation process, particles of tungsten carbide are literally *blasted* onto almost any metal surface. Most important, the temperature of the part being plated never exceeds 400° F., so there is little chance that the base metal will warp or that its metallurgical properties will be changed. Flame-Plated tungsten carbide coatings can be applied in thicknesses from .010 to .002 inches. Coatings can be used in the as-coated condition (125 microinches rms) or ground and lapped to a 0.5 microinch finish.

If your design involves metal parts subject to extreme wear, heat, or fretting corrosion, perhaps Flame-Plating can eliminate some or all of your "headaches"—or make possible some completely new idea.

To find out, write us about your wear problem or request a free copy of LINDE's booklet, "Flame-Plating," F8065. Address Flame-Plating Department.

Flame-Plating by Linde

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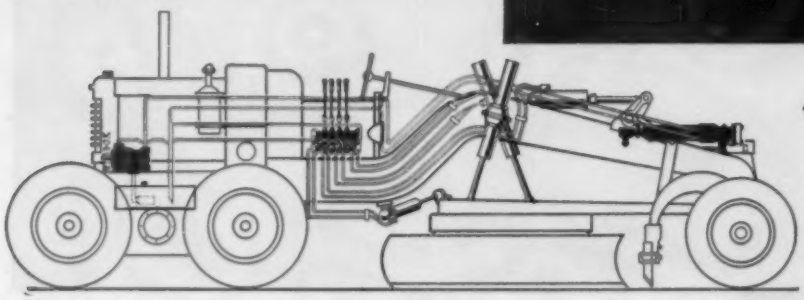
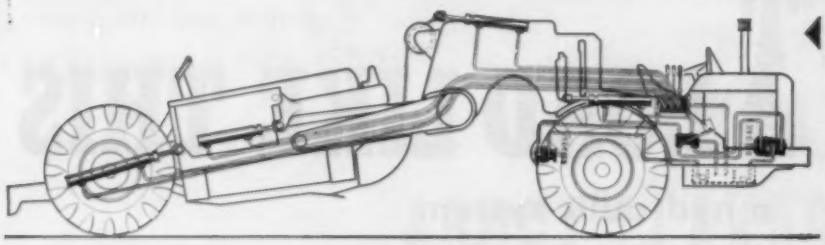
Vickers provides all the inherent advantages of hydraulics and MUCH MORE: (1) the benefits of a nation-wide and full-time field engineering and service organization of unequalled experience; (2) a complete line of equipment enables Vickers to take UNDIVIDED system responsibility thus eliminating any risk of incompatibility of hydraulic components; (3) a hydraulics school for free training of customers' maintenance personnel. For further information, ask for Bulletin M5101A.

VICKERS HYDRAULICS means "QUALITY" CONSTRUCTION EQUIPMENT



Motor grader uses Vickers Hydraulics for:
- maximum blade utility
- accurate and effortless tool adjustment
- positioning scarifier
- convenience of control to operator

Hydraulic motor (not shown) rotates blade on circle. Hydraulic power steering is separate circuit. Central hydraulic system is applicable.

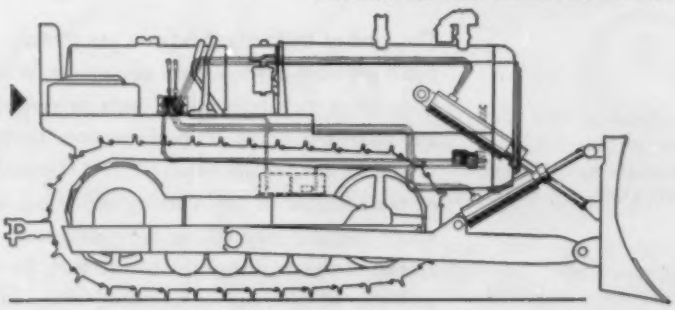


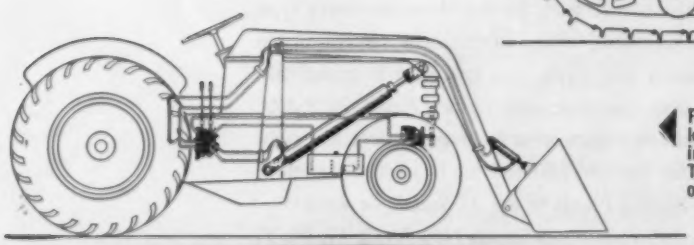
Scraper has VARIABLE rate hydraulic power steering provided by:
- Vickers Double Vane Pump
- Vickers Metering Control Valve
- Vickers Circuit-Splitting Unloading System
- Vickers Overload Relief Protection

Vickers Single Vane Pump supplies power for:
- Fast actuation of bowl
- Fast apron manipulation
- Fast—Positive ejector action

More Work—Less Time—Minimum Maintenance.

Vickers Hydraulics provides fast lifting and angling of bulldozer blade along with exclusive "feathering" ability. Additional tractor attachments added later can be hydraulically controlled by simply adding sections to existing control valve thus eliminating necessity of mounting separate valves.





Fast, easy and dependable operation of front end loader utilizes Vickers Balanced Vane Pump (with inherent automatic wear compensation) and Vickers Two-Section Directional Control Valve. Note simplicity of installation.

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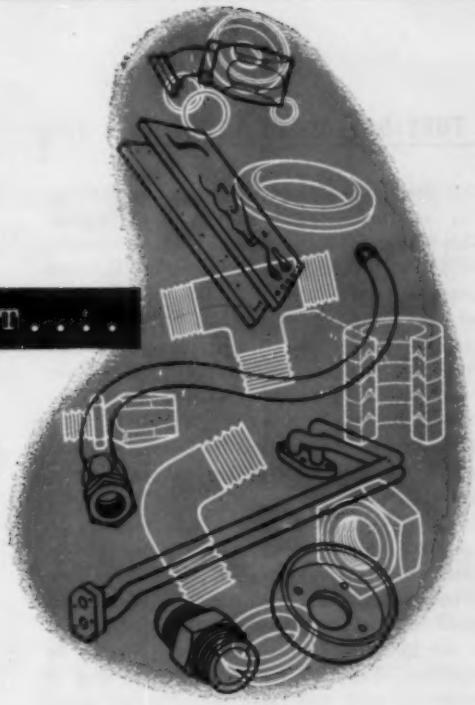
FOR ALL HYDRAULIC UNITS

Circle 150 on Reader Service Card

In preparing this issue on leakage control, we've learned a lot about what can be done about it. Much of this information has come directly

...AN AH STAFF REPORT...

from manufacturers and users of hydraulic machines. To obtain this grass roots material, AH queried 700 men working on the design and maintenance of fluid power equipment. We asked them how much of a problem leakage was and where it occurred most often. We found out about the use of recently developed plumbing components and techniques which are being used to make joints tight.



WHAT THEY SAY ABOUT LEAKAGE CONTROL

LEAKAGE *is* a problem to just about everyone who works with hydraulics. One third of the men who replied to our questions said that they are troubled with it *often;* the rest said it was a "sometimes", unpredictable source of headache. *None* was so fortunate to be completely free from this trouble.

• **Where Does Leakage Occur?**—We know leakage can occur wherever two members of a fluid carrying system are joined together. That means all fluid line connectors; port connections to valves, cylinders, and other components; piston heads and rods; rotating shafts of pumps and motors; and static sealed joints.

Fluid line connectors—tube fittings, pipe joints, and hose connections—and cylinder rod seals are the most troublesome points requiring leakage control. One of the most frequent reasons given for failures at fluid line connections is vibration, either during transportation or actual operation. Another cause for failure of fittings is shock in the system.

The machine vibration problem can often be solved by properly supporting the fluid lines. Another solution is the use of flexible hose where adequate support is not possible.

Improperly prepared threads is a reason frequently given for leakage at pipe connections, especially in sizes over ½-inch. Well-trained pipe fitters and good threading techniques and tools were emphasized when we asked Ken Bandy of McKay Machine.

"Improperly machined ports give us most trouble. Many times ports are

tapped too deep and fittings bottom before sealing. In several cases, paint in the ports prevented a good seal." This was stated by Frank Reynolds, Hydraulic Engineer at Barnes Drill, who continued, "For our own design, we have rigid inspection of ports before assembly. Taps are used only a few times and then sharpened so that there is no pick-up from dull taps. Drills for ports are always sharp. Ports are drilled and tapped by machine so they are square between drill and tap."

Ed Mello, Chief Engineer of Merriman Bros. manufacturers of hydraulic presses suggests use of pipe tap and thread gages to insure good fits. H. U. Rogness of H. U. Rogness, Inc., manufacturers of power package units, recommended using a pipe compound when necessary. Although there have been recommendations against pipe compound it is being used with success. Some of the plastic compounds are good for synthetic fluids as well as petroleum-base. Frank Reynolds cautioned that if pipe compound gets into the system, it can cause malfunctioning of valves and other close-fit components.

At Euclid Div. of General Motors, builders of earth-moving equipment, a number of pipe thread connections have been changed to flange connections and straight thread ports. Plans are to eliminate all pipe threads in sizes over ½ inch. Tinning the threads and the use of forgings instead of castings which can allow leakage because of porosity are ideas offered by P. J. Lindner, Chief Engineer of Hydraulic Press Manufacturing. More information on the problem of pipe thread fits can be found in the article, *Pipe Thread Leakage* in this issue.

Welding is another solution especially for larger size pipe. Harry Carlton, Maintenance Supervisor, Diamond Alkali said, "We weld everything we can."

Tube fittings can give trouble when flares are improperly prepared or when the fittings are overtightened. Poor assembly of flareless fittings is a common cause of leakage. Training of maintenance personnel is important because proper assembly can mean the difference between a tight joint and a leaker.

Many manufacturers are using flareless fittings successfully and find assembly time is minimized. Roundness of the tubing can be a factor and a slightly heavier wall tubing is usually used for the bite-type flareless fittings.

Another important point of external leakage is cylinder rod packings. One cause for this is careless assembly—not seating V-rings properly, scratching the sealing surfaces of the gland by using sharp tools to remove and install the packing. Proper methods and tools are explained in *Installing Packings* on page 104.

Dirty oil is another source of leakage in piston rod packing according to L. W. Cottrell, General Foreman of Saginaw Steering Div., General Motors. This causes scoring which in turn permits leakage. Glenn Millard, an independent designer of automatic cycling presses emphasized the importance of holding close tolerances on all packing glands, piston rods, static seal grooves, threads and cylinder bores. He also stressed the effectiveness of a high polish on all piston rods and indicated the piston should be carefully fitted to insure in-line operation.

In sealing the cylinder piston, some even greater problems can arise because this internal leakage cannot be as easily detected as external leakage. Bernard Fishman, Project Engineer at Simonds Aerocessories said that he is troubled by leakage caused by excessive clearances between the piston and cylinder bore when friction requirements prevent the use of O-rings or other packing. Close control of tolerances is especially important in his manufacturing process.

Keeping oil within normal operating temperature, so that viscosity is maintained and packings are not damaged is an important point in leakage control as shown in the article *Practical Design Ideas*.

Within the past few years much has been done to improve connections to component ports with the introduction of the straight thread fittings. These use either an O-ring seal or metal-to-metal seal and are receiving increasing acceptance along with the jam nut seal using a Teflon insert and the flange type connector which depends upon a O-ring.

Valve sub-plates which use flare fittings that seal with O-rings against the valve are also being successfully applied. Further information on these different types of port seals is contained in the article, *Port Seals*.

Ed Lerczak, Hydraulic Engineer of Oldsmobile Div. pointed out that the conversion to straight thread fittings is of major concern to all maintenance personnel because of the changes in design that are necessary. Speaking from experience as General Foreman in the Machine Repair Dept. of International Harvester, Ft. Wayne, Ralph Eber said that all three methods—straight threads with

Continued on page 158

Some leakage is inevitable.

Leakage control starts on the drawing board. Proper mounting and support of components, piping selection and design to keep oil cool, and careful layout of the system are the initial steps in obtaining a tight machine.

PRACTICAL DESIGN IDEAS

...lead to minimize leakage

• By J. R. Hemeon

FIVE basic rules for leakage control are:

L imited pressure—Insure against surges at any part of the cycle.

E xperience—Learn from the performance of former machine designs.

A ccessibility—Mount the components where they can be easily removed and serviced.

K now-How—Keep up to date on packing developments and new techniques.

S tabilized sump temperature—Limit fluid temperature to 115 degrees F.

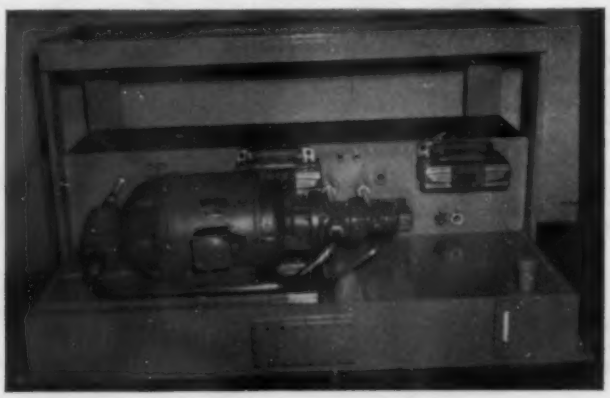
The design, building and operation of in-plant production equipment are integrated into an overall program. Preventive maintenance is an important part of this program, and for hydraulic equipment this emphasizes leakage control. Accurate records have been kept and these show the results of improved design.

Bending machines designed in 1951 have only 25% the leakage of similar machines designed in 1938. Rebuilding eight light die casting machines considerably lowered expensive leakage of fire resistant fluid. Nine heavy die casting machines built in 1953 have only 25% the leakage of 11 medium die casters built in 1946, although the later machines are one third larger.

One of the major factors in this improvement has been careful attention to pipe threads. Cutting male pipe thread nipples on the pipe shop thread cutter is taboo. The hydraulic mechanics are provided with a high quality pipe cutter. The dies must be checked regularly for accuracy and sharp

J. R. HEMEON, *Hydraulic Equipment Engineer, Ternstedt Div., General Motors Corp., Trenton, N. J.*

6 STEPS IN DESIGN AND CONSTRUCTION



THIS POWER PACKAGE will become an integral part of a bending machine used to produce automobile trim parts such as window moldings. All hydraulic components for power and control of cylinders and fluid motors used on this machine are in this package. After a detailed piping layout is drawn to scale, the first step is . . .

crests. Electricians are prohibited from using this thread cutter for electrical conduit.

Commercial ¼-inch nipples have been eliminated for pressures of 800 psi and above. Nipples for high shock loads are made from SAE 2330 steel and the pipe threads chased to the low limit, to engage a minimum of 3½ turns hand tight and 5 turns wrench tight.

Installations using 1½-inch and larger units are made with pipe and flange blocks. Extra heavy pipe is threaded and welded into a flange block which is sealed to the valve port face by a compression O-ring.

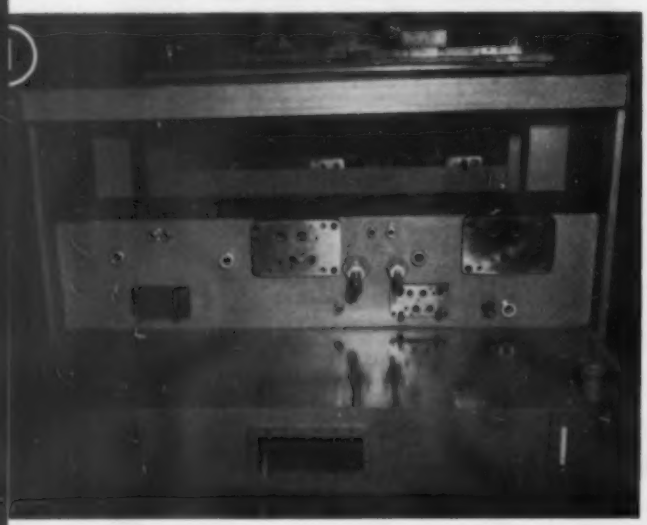
Another design factor which has been important in these improvements has been the use of a valve and tubing chamber above the reservoir. This encloses most of the control valves and tubing, except for the sub-plate mounted 4-way directional valves which are solenoid operated. Although not according to JIC Standards, this design insures that all control valve and tubing leaks go back to tank.

The preventive maintenance program specifies that the valve chamber cover shall be removed and all leaks repaired at economic intervals. Sets of open, ratchet wrenches which are used in construction are also available to maintenance personnel.

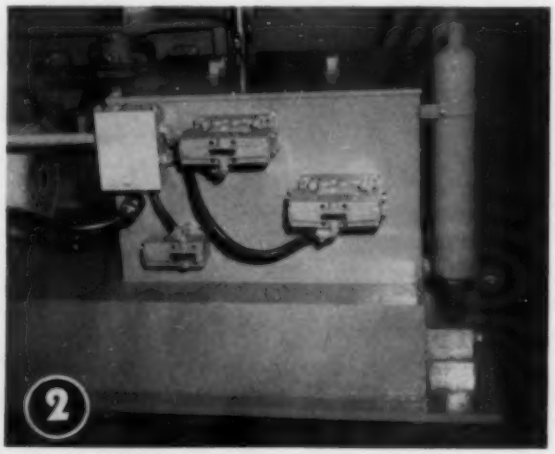
Keeping the oil cool is important in leakage control. One way of doing this, illustrated in the views below, is by installing a fin cooler on the pump discharge line so that air is drawn over the fin cooler by the totally-enclosed fan-cooled motor and exhausted over the pumps which are flange mounted to the end-bell on the motor.

The illustrations on these pages show how machines are designed for leakage control. ▼▼▼

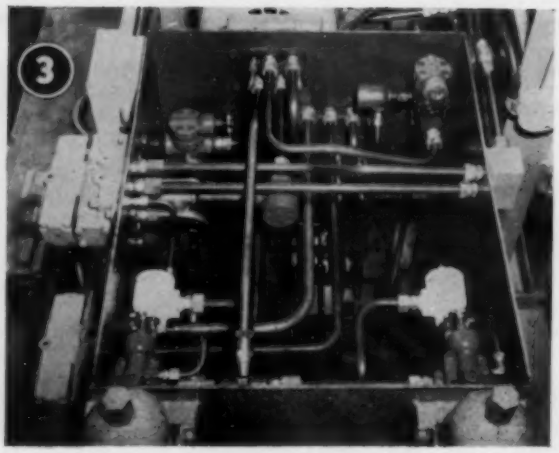
. . . RESULT IN LONG LIFE AND LOW MAINTENANCE



FABRICATED RESERVOIR and valve panel is accurately pre-drilled, insuring the specified layout and eliminating valve strain which can cause leakage. Low tank with internal peripheral circulation dissipates maximum heat. Sub-plates are shown installed for mounting 4-way valves on bender power package.



NEAT APPEARANCE and leakage control are both achieved when solenoid valves are sub-plate mounted to outside of valve and tubing chambers.

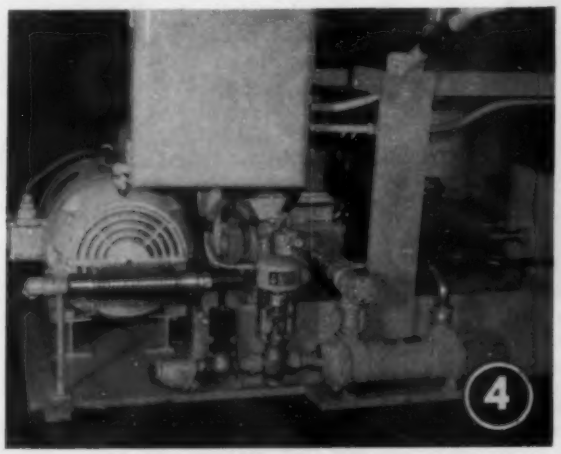


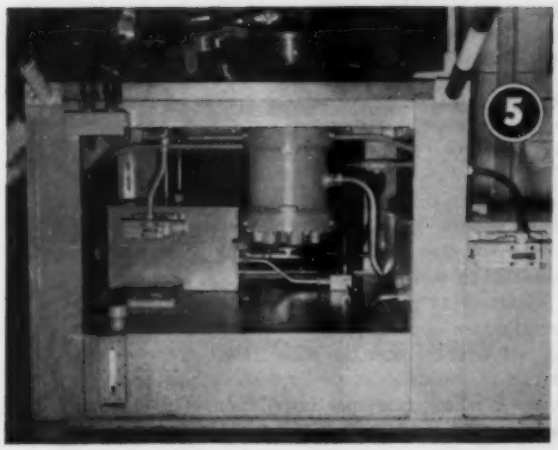
INSIDE OF CHAMBER proves the benefit of scaled layout drawings of valves and tubing. Arrangement is planned to use long radius tube bends instead of elbows, nipples, unions, and tees which are subject to leakage.

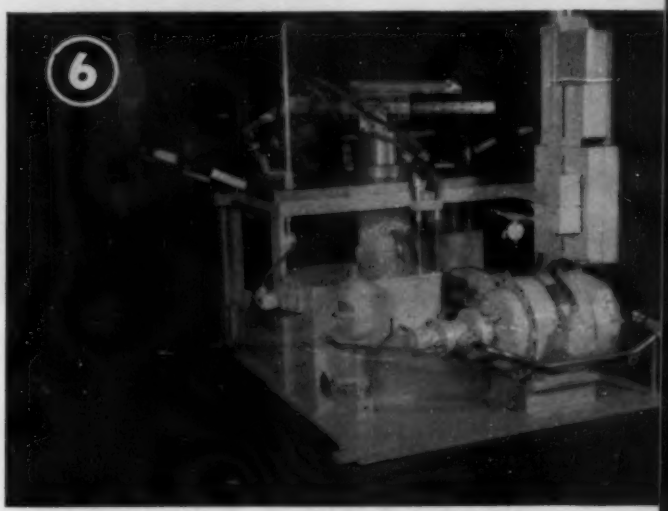
Results of Leakage Control Program		
MACHINE	DATE DESIGNED	LEAKAGE gal/100 hr
Benders	1938	4.5
	1951	1.03
Light Die Casting Machines	1946	29.2
	Rebuilt for Fire Resistant fluid	19.0
Medium Die Casting Machines	1946	46.4
	1953	10.2

Previous articles in APPLIED HYDRAULICS *on maintenance and leakage control are:*

Magnetic Plug Assemblies
J. R. Hemeon Mar. 1957
Effect of Sludge on Hydraulic Oil
B. M. Dunham Feb. 1957
Why and When to Drain Hydraulic Oil
R. Q. Sharpe Aug. 1956
Prevent Rust in Hydraulic Systems
Apr. 1956
Packings for Air and Oil Cylinders
E. P. Stahl Mar. 1956
Reclaiming Fire Resistant Fluids
Nov. 1955
Piston Rings for Hydraulics
E. J. Taschenberg, J. W. Pennington
Nov. 1955
O-Ring Maintenance
R. G. Dempsey Oct. 1955
How to Select Fluid Line Sizes
A. E. Morris Aug. 1955





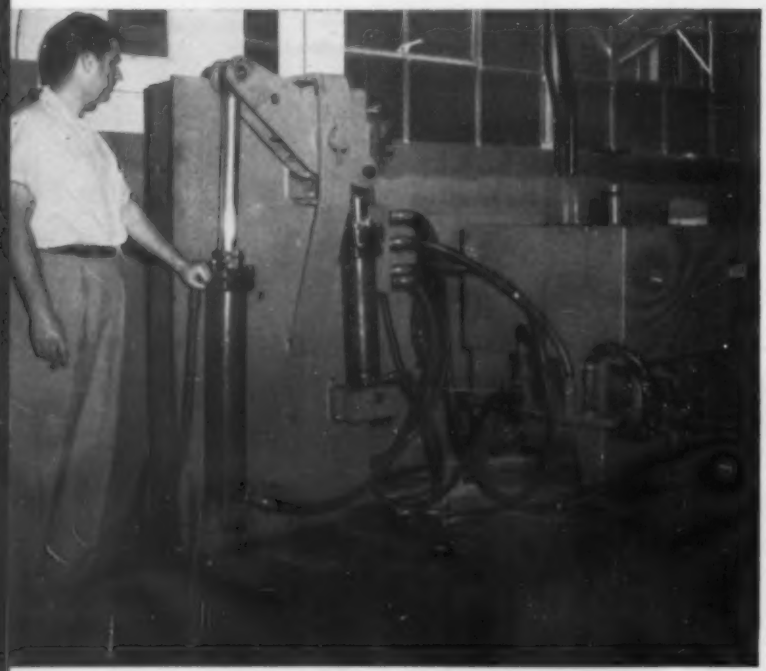


OIL COOLING ARRANGEMENT has fin cooler installed at air intake to motor. Heat exchanger ensemble with water and oil temperature controls has been installed for future loads above 15,000 BTU/hr.

TWO-WIRE BRAID HOSE used on the bender has been very effective in leakage control. Only piping outside valve and tubing chambers is to rotary actuator and clamp and wipe cylinders.

HIGH TORQUE BENDER built in 1955 incorporates features for leakage control. Two chambers contain valves and tubing, so that leakage goes directly to tank.

What packings will last the longest in my machine?
Should I use V-rings, O-rings, or piston rings?
These are the questions many designers ask.
Here's how one group finds out for itself by . . .



TESTING PACKINGS

...on a plant-built machine

PACKING on earth-moving equipment must be especially reliable because of maintenance problems when these machines are used far from sources of replacements. To get first-hand information on how long a packing will last Gradall engineers at The Warner & Swasey Co. in New Philadelphia, Ohio designed a test set-up for life testing.

• **Tester Design**—Two cylinders are mounted with a pivoted beam, and the packing under test is installed in the piston rod gland or piston head of one of the cylinders. The other cylinder is exhausted through a relief valve to provide the load for the cylinder under test. These production cylinders are 5-inch bore by 23-inch stroke and 4½-inch bore by 14-inch stroke, and are used as hoist and tool cylinders in the Gradall.

The smaller cylinder is bolted to the short end of the pivoted beam; the larger cylinder is bolted to one of two positions on the long end of the beam. Cycling is controlled by a 4-way solenoid valve actuated by a cam-operated limit switch. This cam is driven by a small motor.

Operation of this tester has produced some valuable information about cylinder packings. A packing is tested for about 50 hours at approximately 5 cycles per minute and then examined for wear. If it still looks good, it is tested further on an actual machine. This means an accelerated life test and faster results, as well as a good correlation with actual service life.

• **Test Results**—One of the results of working with this tester is a preference for a square, molded, reinforced neoprene packing for piston heads. Packing for piston rods is not as critical and little performance difference has been noted in the different shapes. V-rings are being used because they are inexpensive and readily available. Five of these are used to seal 2000 psi.

Contrary to most hydraulic equipment, high oil temperature is an advantage in this tester. Because oil is forced through the relief valve on the *extend* stroke of the cylinder under test, the oil heats up more than in an actual installation. This further accelerates life testing. ▼▼▼

INSTALLING FLUID POWER LINES

PROPER preparation and assembly techniques of the pipe, hose or tubing used to join the various components of a hydraulic system can do much to minimize leakage both initially and after the circuit has been operating for some time. Since the greatest percentage of leaks in a hydraulic system occur at fluid line connections, the importance of making them properly cannot be over-emphasized. A leaking circuit is not an efficient circuit no matter how well designed it may be and despite the quality of the components which may have been incorporated. Proper preparation of the pipe, tubing or hose used to connect up a system also pays dividends in continuing efficient performance of the various system components.

• **Pipe, Tube or Hose**—Initial step in properly piping up a system is selection of the proper conductor; that is pipe, tube or hose. In all cases where hose is not necessary for its flexibility, tubing should probably be used. Tubing is advantageous because it can be bent and thus requires fewer fittings and connections. The connections thus eliminated may be considered as just that many potential sources of leaks eliminated.

Tubing must, of course, be selected for the required operating pressure, Table 1, and should be annealed dead soft. The annealing is extremely important since it facilitates bending and flaring. Additionally, bending hard tubing can weaken the walls so that the bend may rupture under pressure.

When bending tubing, the effect upon leakage at tube fittings as a result of the bend must be considered. A bend too close to a fitting may result in deformation of the tubing at a point where it is necessary that the tubing be perfectly straight and circular in order to seal properly. Bends should be carefully made, preferably with a commercial tube

TABLE I

JIC RECOMMENDED MINIMUM WALL THICKNESS FOR STEEL HYDRAULIC TUBING

Tubing OD (in.)	Minimum Wall Thickness (in.)			
	0-200 psi	200-500 psi	500-1200 psi	1200-3000 psi
⅜	0.035	0.035	0.035	0.065
½	0.035	0.035	0.035	0.075
⅝	0.035	0.035	0.049	0.095
¾	0.035	0.035	0.049	0.109
⅞	0.049	0.049	0.065	0.109
1	0.049	0.049	0.065	0.120
1¼-1½	0.065	0.065	0.065	

bender, to avoid flattening, wrinkling or thinning of the tube walls at the bend, Figure 1. The sharper the bend, the more likely it is that poor bends will be made. Minimum bend radius should not be less than three times tube diameter.

In general the number of bends in a tube run should be as few as possible. However, any tube run should have at least one bend to allow for expansion and contraction, with changes in temperature. Thermal expansion or contraction can strain the fittings and cause leaks, particularly in extremely short runs. Tube runs should be made up accurately so that it does not become necessary to strain the ends into position to make the initial assembly for similar reasons.

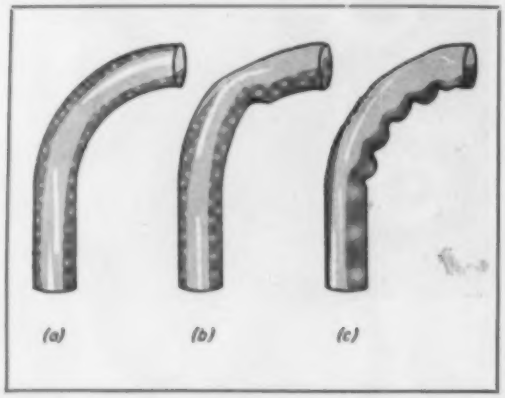


FIG. 1. Poor tubing bends. At *a* a flattened bend; *b* a kinked bend; *c* a wrinkled bend. Use of a good tube bender should eliminate poor bends.

FIG. 2. Correct and incorrect tube flares.

• **Installing Tube Fittings**—Tube fittings for hydraulic use must be flared or flareless types. No soldered fittings should be used. Although certain types of flareless fittings may not require that the tube end be square, it is usually required practice that tube ends be square and free of burrs both inside and out. A tube cutter will give much more satisfactory results in this respect than a hacksaw.

With flared-type fittings the flare should be carefully made with the correct flaring tool. Correct flare angle for hydraulic fittings is 37 degrees from the centerline of the tubing and use of a tool of the correct angle is important since 45 degree flares are commonly used for certain applications. Flares must be the correct length, Figure 2, or the fitting will not seal properly. The sealing surface of the flare should also be quite smooth. A good rule with any type of tube fitting is to follow the manufacturer's instructions for assembly; don't guess.

• **Threaded Connections**—Threaded connections of the common tapered pipe thread type are being used less and less in hydraulic systems. However, they are still being used and other types of threaded connectors are coming into use. When any type of threaded connection is involved, care should be used to see that the threads are smooth, clean and undamaged. If a pipe thread compound is used, it should be applied sparingly to only the male threads. The compound should not be applied closer to the end of the threads than the third thread.

• **Hose Lines**—Primary precautions to be observed when using flexible hose lines are to avoid any unnecessary twisting or bending of the hose. Twisting is a matter of improper installation, Figure 3, bending or flexing is the result of improper layout. Elbows, adapters or other fittings should be used to eliminate bends in the hose when possible, Figure 4. When hoses are used to connect moving parts, the line layout should be such that the hose will at no time be bent to a smaller radius than that

SHOULD PIPE COMPOUND BE USED?

This question is often asked. Many recommend that pipe compounds not be used at all since they introduce the possibility of system contamination and value as a sealant has been questionable. However, James Robinson, Chief Engineer, Industrial Products, Vickers Inc., recently stated, ". . . *we are achieving almost* 100 *percent success* [in sealing pipe threads] *by the use of a patented paste which is nondrying, impervious to air, water, steam and oil. This paste has suspended in it about* 70 *percent pure metallic lead. The compound will not harden, evaporate or corrode and insures a leakproof joint and still provides ease for removal of relatively permanent plugs.*" This certainly seems to indicate that the right compound, properly applied is of real value.

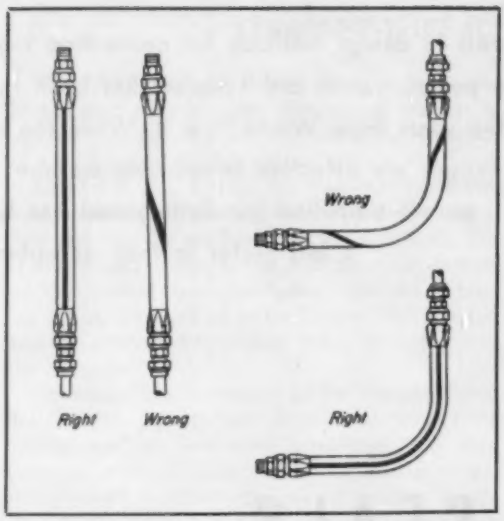


FIG. 3. Hose should never be twisted when installed. The stripe on the hoses indicates the twisting in the incorrectly assembled hoses.

specified by the hose manufacturer. Manufacturer's recommendations for minimum bend radius will vary with hose size, operating pressure and the degree of bend. A good rule of thumb is that the hose should never be bent to a radius smaller than ten times the hose outside diameter.

When making up hose assemblies, the manufacturer's instructions should be consulted and closely adhered to. Since these instructions vary widely from manufacturer to manufacturer, no standard procedure to cover all cases can be given.

• **Supports and Vibration**—Since one of the principle causes of hydraulic line breakage is vibration which usually causes breaks at fittings, all lines should be well supported. Spacing of the supports and the number required will vary with the amount of vibration present.

Of course, the best way to eliminate line breakage as a result of vibration is to eliminate the vibration if possible. If vibration is mechanical and transmitted from a machine to which the lines are attached, a flexible hose may be used to insulate many of the lines from the source of vibration. In the event that there is actually vibration or hammer in the hydraulic system, an accumulator should, perhaps, be installed to absorb the energy surges in the system. Circuit redesign may, however, be the most likely way to eliminate this problem.

Pipe supports should not anchor lines so firmly that normal contraction and expansion of the line is impossible. All bolted supports should be checked periodically to see whether or not the bolts have loosened due to vibration and the bolts retightened if necessary.

Hose is not as subject to damage from vibration as rigid lines. However, pressure surges or hammer will shorten hose life. Hoses should always be positioned so that they do not rub or chafe and thus wear out the covering.

• **Cleaning**—All hydraulic lines should be thoroughly inspected before installation to be sure that they are clean and contain no foreign matter. Tubing, pipe and fittings may be brushed with a wire brush internally, sandblasted or pickled to remove rust, scale and any other foreign matter. Sandblasting should not be used if there is the slightest possibility that particles of sand may be retained in blind pockets or cavities. Of course, it is necessary to pickle long lengths or short pieces bent into complex shapes.

Tubing or pipe should never be welded, brazed or silver soldered after assembly since it would be impossible to remove any scale or other contaminant inside.

When hose assemblies are made up, they should be inspected to be sure that no shreds of the cut material are lodged in the bore of the hose. The hose assembly should also be inspected to be certain that the fittings are properly installed. Actual proof testing to ascertain that the hose does not leak at pressures at which it will be used is perhaps the best inspection technique which can be used. Time and embarassment saved by discovering a leaker on test will more than justify proof testing in many cases.

• **Storage**—Properly prepared lines are little better than improperly prepared lines if prepared and then improperly stored for an interval before actual assembly. All prepared assemblies to be stored should be properly treated to prevent rusting or other types of corrosion and then capped or sealed in some fashion to prevent the entry of foreign matter. Common masking tape may be used to seal openings. There are also comparatively inexpensive commercial devices available for capping or plugging openings. ▼▼▼

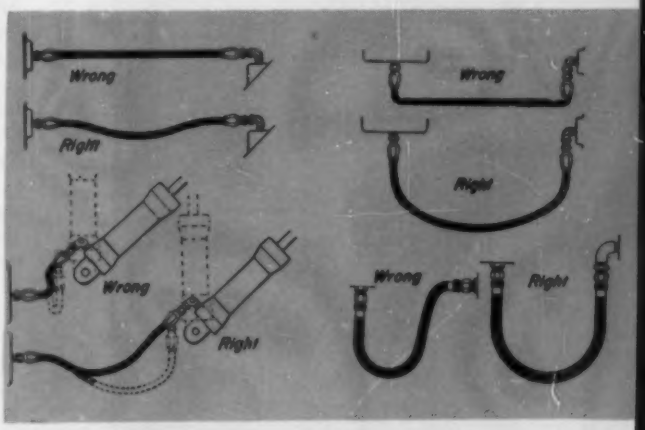
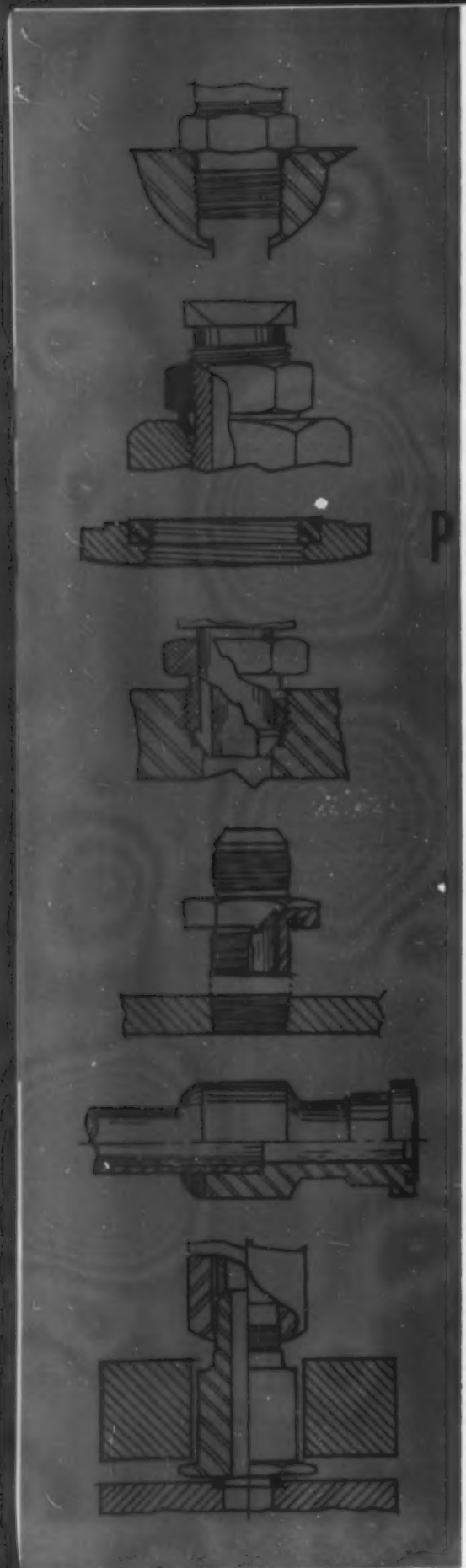


FIG. 4. Hose line layout should always avoid unnecessary bends and short radius bends. Some slack must always be left in a hose line to allow for expansion and contraction due to pressure variations.



Progress in design methods for connecting piping to pumps, valves and cylinders has been rapid in the years since World War II. While the new designs are effective in reducing leakage and permit simplified installation, cost has been a big factor in their acceptance.

PORT SEALS

. . . what's available

. . . what they can do

FLUID POWER fitting and component manufacturers have been working steadily to eliminate the tapered pipe thread as a sealing element. While some modifications in the degree of taper have improved the performance of threaded connections, the trend has been to other types of seals which do not depend upon the interference of threads for a seal.

One of the early improvements to reduce leakage at valves was sub-plate mounting first introduced about 23 years ago. This permitted installing pipe with a higher wrench torque because it reduced the spreading effect on the valve itself. Although the early gasketed installations were an advance, they had to wait until the development of more effective seals, especially O-rings, before they were fully effective.

A major advance in port sealing was the development of the "AN" port configuration and fitting which had a straight thread instead of the tapered thread and used an O-ring as the sealing element. Because of the difficulty of machining the port, as well as its ineffectiveness under certain conditions, this design was recently simplified to the present SAE, O-ring, straight thread fitting. An even more recent development has been the metal-to-metal seal which eliminates the O-ring.

Other designs to seal the present pipe threads employ a lock nut with a Teflon insert which forms the seal, and a fitting to seal pipe threads with an O-ring. Even the straight threads of sub-plates have been eliminated by a threadless sub-plate design which has an insert to perform the functions of O-ring seal face, and fitting for the connected piping.

The components described on the following pages have all developed because of one need—Leakage Control. They *have* proved effective; they *can* be the answer to your leakage problem.

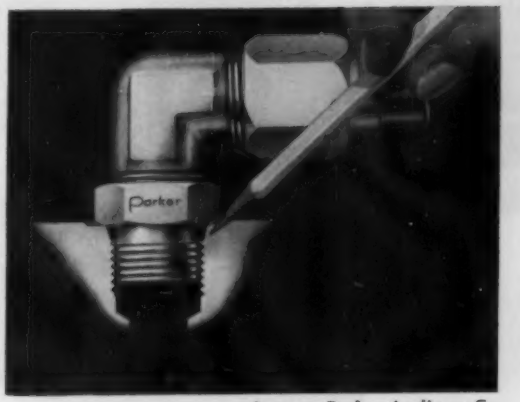
STRAIGHT-THREAD FITTING WITH O-RING

The "AN" straight thread fitting was a step in the right direction for eliminating leakage in tapered pipe thread joints. To correct the difficulty of machining the double conical surface which was required for this fitting, the SAE- O-ring fitting was developed. This requires only a single conical face that can be machined by a single tool. The O-ring, which is compressed into the cavity formed by this conical face, the fitting, and the locknut are not as deformed as in the former "AN" design and this reduced deformation results in higher sealing pressures.

An outstanding advantage of the straight thread design over pipe threads is that elbow and tee fittings can be accurately positioned and then tightened without danger of overtightening or undertightening to achieve the proper position. In the straight fitting with straight threads the hex lock nut is integral with the fitting. In elbows and tees the lock nut is fitted to its own threads on the fitting so that the fitting can be positioned and the lock nut then tightened. An additional method for positioning these straight thread fittings is the use of a straight fitting to make connection to the component with a flare type, swivel elbow or tee.

The fittings are available for flare or flareless tube connections. The dimensions of the fitting and its lock nut have been limited so that it can be used with components originally having tapered pipe threads without major changes in component dimensions.

The O-ring straight thread fitting has been effective for a wide range of pressures including surge pressures encountered in hydraulic systems. The fitting is also effective in compressed air circuits.



Courtesy Parker Appliance Co.

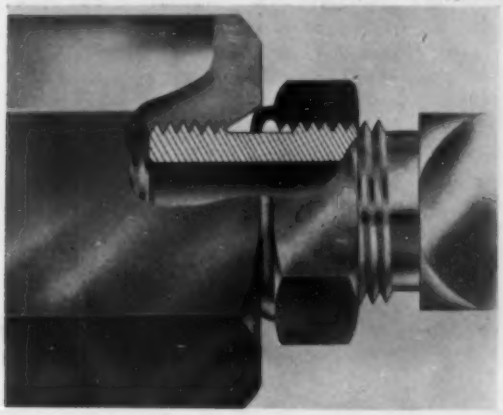
STRAIGHT THREAD FITTING WITH METAL-TO-METAL SEAL

The port for the captive nut fitting, shown at left below, is machined with a 60° included angle leading into a threaded counterbore. Elbows, tees, and other adjustable designs have a swaged captive nut which seats in the port. A captive metal ring is used on the straight fittings allowing for temperature and pressure fluctuation in much the same way as an expansion joint. It also serves as a cushioned tapered lock washer.

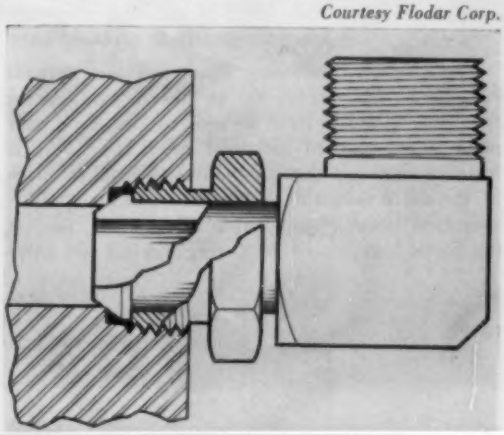
The camming action of the port exerts force on the lip of the nut as it is torqued into place on assembly. This camming action closes the lip of the nut tightly around an unthreaded portion of the fitting, and at the same time forces it against the angle of the port as final torque is applied. Escape of fluid can occur only after the threads in the port or fitting have yielded. The fitting has excellent resistance to vibration because of the lock washer effect of the ring or the spring tension grip of the nut. The 60-degree angle of the port provides angular dispersion of port stress and reduction of strain at critical areas. Commerical applications require a minimum of precision, and class 2 threads, 125 micro-inch finish, and liberal machine tolerances can be used.

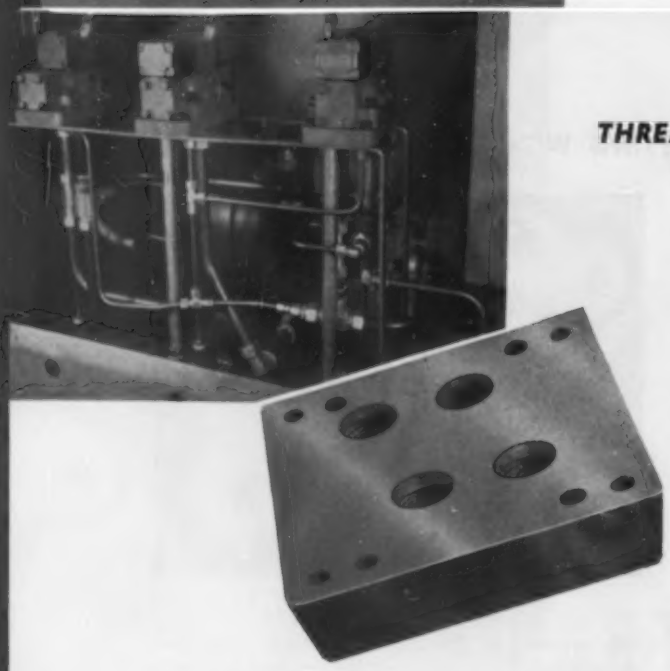
In the fitting recently introduced shown at right below, the sealing seat is formed when the nut is tightened down. This nut is held on a smooth section of the fitting stem. The step which forms the sealing surface is formed with a step drill or counterbore after the hole has been drilled. The straight threads are then tapped. No special tools are required and no special finish of the normal seat is needed. This eliminates any grinding or finishing to obtain a seal. In spite of its compactness, the fitting requires only standard tools.

Courtesy L & L Mfg. Co.



Courtesy Flodar Corp.





THREADED SUB-PLATES

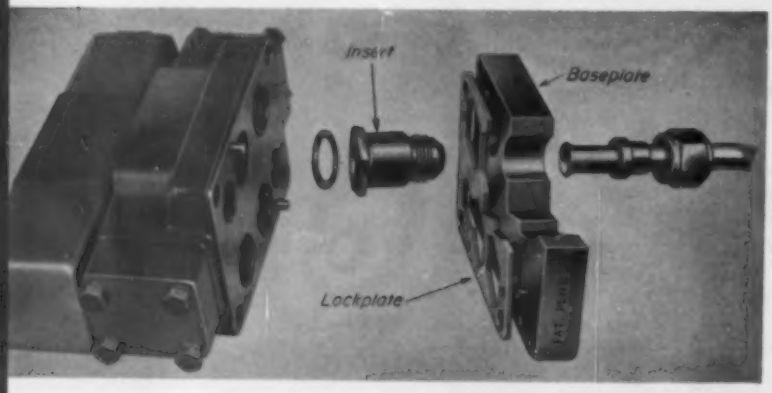
The first big step in eliminating pipe threads from valves was the development of sub-plates. Probably the biggest advantage that was achieved was the simplified removal and replacement of valves, and this has become increasingly important with more integration of equipment where down-time is more expensive. However there are other advantages of sub-plate mounting. Because pipe threads seal by interference of the threads, there is some spreading of the port, and this is magnified with over-torquing. With sub-plate mounting this strain is isolated from the valve itself and any binding or sticking that it might have caused in the valve is avoided.

Another advantage of sub-plate mounting is the elimination of leakage due to vibration. This is a major cause of loose connections when valves are "hung on the line" supported only by the connecting pipe or tubing. The use of sub-plates assures a solid mounting for the valve.

Sub-plate mounted valves have had universal acceptance, and JIC Standards state that gasket-mounted valves shall be used whenever possible. The standards recommend the use of pressure-energized seals in these installations. The seal is usually an O-ring which is installed in a counterbore on the valve base. The O-ring is compressed and forms a seal with the surface of the sub-plate.

One of the difficulties of sub-plate mounting larger size valves has been deflection of the mounting plate and consequent extrusion of the O-ring. For this reason, sub-plate mounted valves have usually been limited to 1¼-inch for 50 gpm and less. Valves larger than this have generally been designed for flange connections. However there are developments to sub-plate mount these larger size valves by increasing the number of mounting bolts and locating them strategically around the ports subjected to pressure. This minimizes the deflection of the sub-plate and prevents extrusion of the O-rings.

THREADLESS SUB-PLATES



Courtesy Petch Mfg. Co.

The threadless sub-plate eliminates pipe threads completely by employing an insert that serves three functions: To form the seal, conduct fluid, and make connection to the fluid line. The insert is installed through the sub-plate and held in place by the valve mounting bolts and a lockplate which keeps the insert from turning. The sealing face of the insert compresses an O-ring against the valve base to form the valve port seal. The other end of the insert extends through the sub-plate and can be either a male or female flare, flareless, male or female pipe thread or plug. The basic nominal sizes have the same combination of body, tube, and pipe thread sizes as the AN 815 and AN 816 fittings. The inserts are available in a full range of basic and reducing sizes.

An important advantage of the threadless sub-plate is the elimination of leakage through porous sub-plates. Pressure fluid is carried through the insert and has no contact with the cast sub-plate. The insert is machined from open-hearth steel bars. The surface finish and density of the sub-plate is not critical.

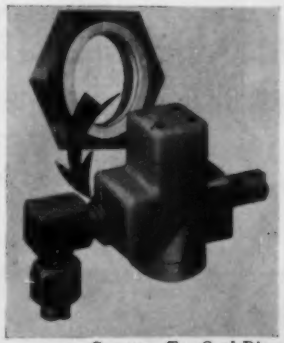
For mounting adjustable fittings such as elbows and tees, swivel type fittings are connected to the straight insert by a flare fitting. For multiple valve mounting, single sub-plates can be prepared according to the specific valve layout. This multiple valve installation uses the same insert as the individual valve installation.

DEVICES FOR PIPE THREADS

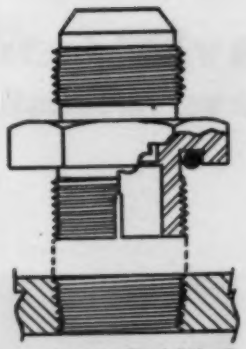
As attractive as the newly developed straight thread devices are, there are still many pipe thread connections being used. Part of this is a matter of acceptance of the straight thread design. Part is a matter of availability of components with straight thread ports or the necessity of converting pipe threads to straight threads. Two devices which have been developed to deal with this situation are a lock nut with a Teflon insert and a pipe-thread, straight-thread adapter.

The lock nut is designed to seal pipe joints, and consists of a lock nut with a threaded Teflon insert which extends about half the distance through the nut and slightly beyond the face of the nut. When installing a fitting or pipe into a component, the nut is threaded on the fitting. The fitting is then threaded for four threads into the port and positioned in the proper direction. The lock nut is then tightened down against the port to form the seal.

Tests with this unit have shown no trace of leakage at 2500 psi static and fluctuating pressures. One test assembly was a ½-inch pipe, hand tightened into a fitting with the Teflon insert lock nut tightened with only moderate torque.



Courtesy Tru-Seal Div., Flick-Reedy Corp.

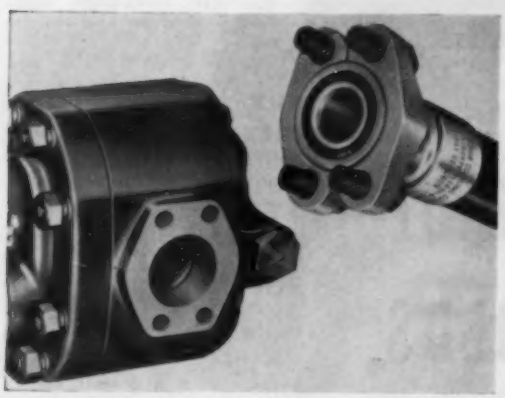


Courtesy Petch Mfg. Co.

The straight thread adapter has four slots cut in its port thread section giving a locknut action in the pipe thread port. A groove on the under side of the nut contains an O-ring which seals against the port. Under typical high shock and vibration conditions as encountered on die casting machines, the adapter has held pressure to 2000 psi with no leakage after several months service.

Another field service installation has been successful in cycle testing to 874,000 cycles at 250 to 3000 psi each cycle, 60 cycles per minute.

FLANGE CONNECTIONS



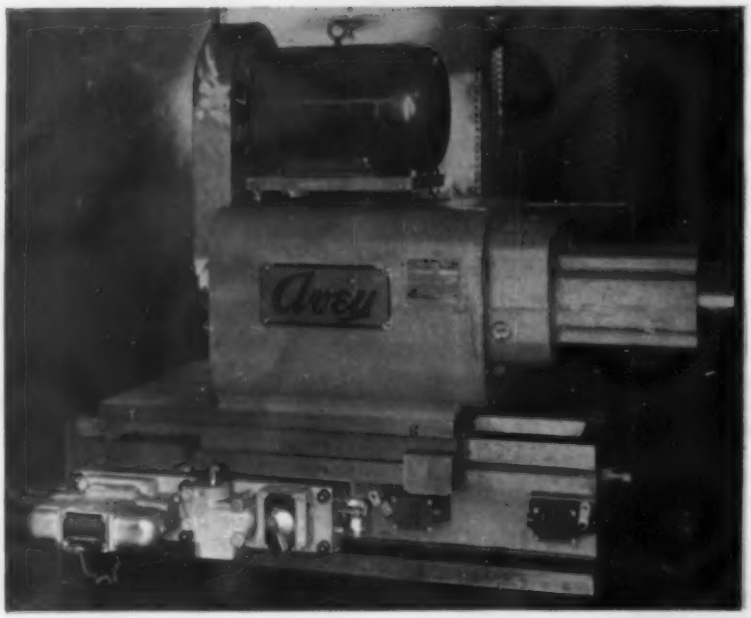
Courtesy Anchor Coupling Co., Inc. Pat. Re. 20629

Flange connections are usually used for larger size valves and pumps. In valve sizes of 1¼-inch and above the combination of welded fitting and flange connection usually provides a leakproof connection. One design of flange coupling which can be used with hose, pipe, or tubing is the split flange type illustrated. This fitting has an O-ring contained in a groove and this is compressed against the port to form the seal.

A design feature of this fitting is the elimination of unbalanced moments in the clamp. Consequently, tilting of the clamp and extrusion of the O-ring are eliminated. Removal of the bolt from one end of the clamp opens the clamp fully and permits the flanged head to be removed. This also permits easy assembly in close quarters.

Repeated removal and installation of the flange fitting is possible, and the elimination of tapered seats removes the possibility of leakage when these seats are scored. Either pressed-on or clamp type couplings are used with hose connections. The pressed-on type are factory assembled and are primarily for original equipment installations where cost and appearance are of the utmost importance. The clamp type couplings are used where immediate repairs are necessary or where special units are being assembled.

Increased use of manifolds for mounting pneumatic and hydraulic valves is emphasized in the AH survey. More than 80% of the respondents said that some type of brazed, welded or drilled manifold is being used in their designs.



BRAZED, seven-plate manifold is used on this drilling unit.

USE OF VALVE MANIFOLDS

...reduces potential leakage points

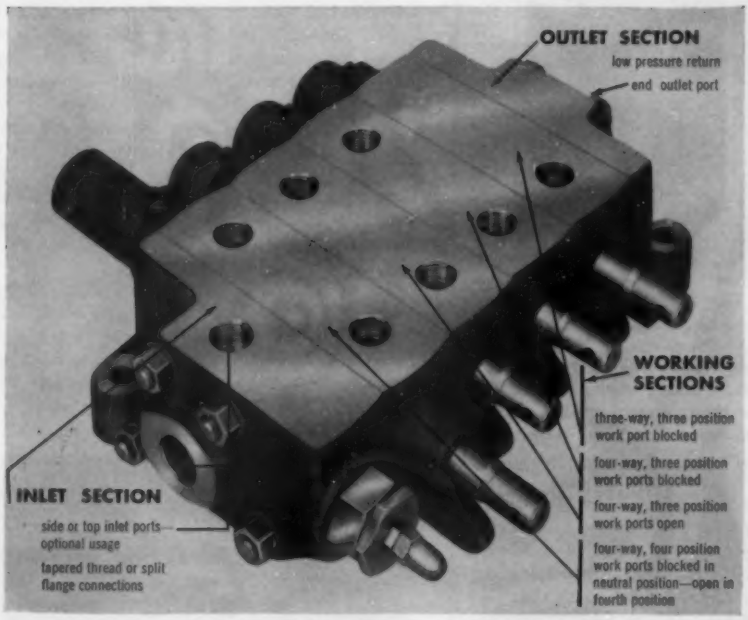
COMPLEX hydraulic and pneumatic circuits are made more compact by the use of manifolds. Fewer threaded connections mean less maintenance and leakage. System efficiency is improved because valves are closer together and flow paths correspondingly shorter. This results in less pressure lost in overcoming line resistance. Less volume in a hydraulic circuit improves dynamic conditions by reducing the amount of compressible oil.

Elimination of tubing runs which are subject to vibration is also a step toward the control of leakage accomplished by the use of manifolds.

In general there are no limits to the size of manifolds except those dictated by practical reasons. It may be an advan-

size for size...

Commercials Oil Hydraulic Valves
give Original Equipment Manufacturers up to 25% more gpm capacity


OUTLET SECTION
low pressure return
end outlet port
WORKING SECTIONS
three-way, three position work port blocked
four-way, three position work ports blocked
four-way, three position work ports open
four-way, four position work ports blocked in neutral position—open in fourth position
INLET SECTION
side or top inlet ports—optional usage
tapered thread or split flange connections

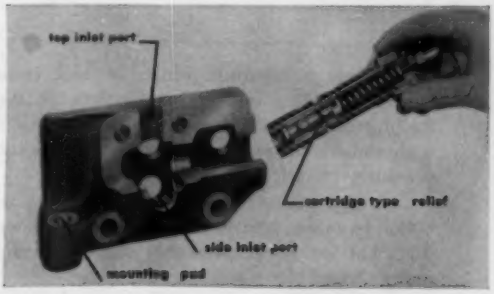
Available in three sizes, you will find these new "B" series valves have higher performance ratings than other valves. To assist you in selecting the size best suited for your application, data is available to show their internal pressure drop for different volumes of flow under varying operating pressures as encountered in actual operation.

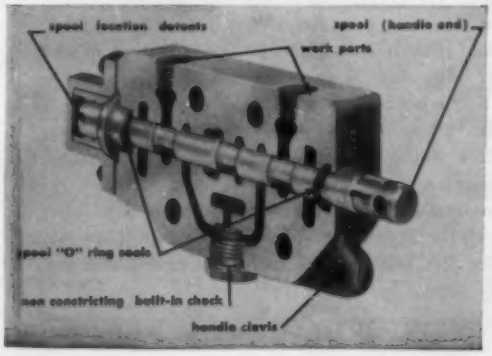
Every working section of these new valves has its individual built-in check which blocks against all return flow until the return pressure is overcome by pressure build up from the pump. This means that irrespective of the number of working sections which may be in operating position no load drop can occur. Danger resulting from erratic operation or one load dropping while another is being positioned is eliminated. Not even the slightest pre-lift drop can occur as a load is being positioned.

Other important new features have been incorporated in these new valves which reduce their internal pressure loss. Internal passageways are larger, of more uniform cross section, free from abrupt change of direction and have smoother wall surfaces. Spools are solid and without internal restriction. Thus constriction to flow inside these valves is less than other valves and their pressure drop has been improved as much as 25%. All sealing between sections and at ends of spools is by O-rings instead of gaskets, so now you can use these valves at working pressures up to 2000 psi and have trouble free, leak proof operation with the timing action so exact and precise that "inching" loads to exact position is a stable operation.

Safety protection for the hydraulic system, plus overload protection for the structural members and tools of the machine in operation, are provided by a new combination overload relief-pressure control valve. It is built into a complete cartridge and is easily removed as a unit from the inlet section of the valve bank. Thus inspection of this important sentinel is easy and replacement can be accomplished in a matter of minutes.

inlet section
Cartridge overload relief
2000 psi pressure



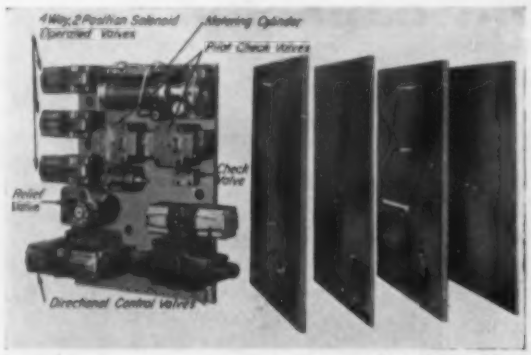


working section
3 sizes—10 to 65 gpm
Multiple section,
parallel circuit

Write to Dept. A-18, The Commercial Shearing and Stamping Company, Youngstown, Ohio; Chicago, Illinois; Salt Lake City, Utah.

COMMERCIAL
shearing and stamping

SANDWICH CONSTRUCTION



Almo Tool Company

Hydrogen brazing is accomplished so that no copper is left in the oil passage channels. Copper is brazed on the faces of plate. The plates are stacked under pressure and heated in an electric furnace. Copper flows to contact surfaces; excess copper flows out through open parts.

In most cases steel plates have been used for the sandwich construction. Recent developments leading to successful brazing of cast iron to steel now make possible more economical construction using cast iron as the "meat" of the sandwich.

Because liquid brazing material and liquid flux are of similar viscosity at brazing temperature it is difficult to eliminate flux from the joint after it has done its work of dissolving oxides. To braze flat plates and form a solid, flux-free joint, capillary action, surface tension and free flow of braze have been carefully analyzed. Capillary forces pull the liquid brazing alloy into the area to be brazed while free flow of the alloy forces out the liquid flux.

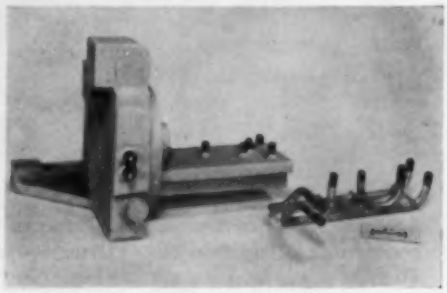
Number of plates in the sandwich depends on the required oil-carrying passages which lead from one valve to another.

TUBE DESIGN

Use of a nickel-chrome-boron, high temperature brazing alloy has solved the problem of brazed joint separation for Al-Fin Division of Fairchild Engine and Airplane Corp. in their manufacture of molecularly bonded, bi-metallic hydraulic manifolds for guided missile application. The brazing alloy, possesses excellent joining characteristics, resists separation despite 1300°F process temperature.

The manifold consists of a preformed and brazed cluster of stainless steel tubes that is Fe-Mag bonded and cast into a magnesium housing. The four ¼-inch tubes are accurately positioned and brazed in place with ⅛-inch drill-rod cross members to form a rigid, dimensionally stable assembly. Brazing rod of ⅛-inch diameter is used.

Copper brazing cannot be used in this application because of copper's high solubility in the bonding bath resulting in separation of the brazed joints. Fabrication by welding is difficult because of the tendency of thin-walled members to fracture when joined to the thicker sections.



tage to use a manifold which is thick enough to permit mounting one or more valves on the side. Each problem must be considered on its merits, with consideration given to the valves being used, pressure, capacity for drilling, etc.

For high pressures—over 4,000 psi—it may be better to make manifolds from steel plate or forgings, but for lower pressures aluminum alloy has many attractions.

• **Application**—A seven-piece sandwich manifold is used on the Avey Drilling Machine Company's Hydro-Way unit. It measures 3⅝ x 21 inches and is 4½ inches thick. With this manifold, rapid advance, feed, fine feed, dwell and rapid return are obtained. Before this compact unit was designed, the flow control valve, deceleration valve and four-way valve were all individually mounted with sub-plates and brackets. Custom cutting and fitting of the tubing made a costly and congested system. On this production machine, cost of the manifold is more than offset by the reduction in assembly costs alone. Power losses have proven to be less than with conventional tubing assembly.

This drilling machine is one of many production machines where a firmly established circuit makes a permanent manifold desirable.

Packaged or manifold systems do more than just clean up the appearance of the equipment. They do a better job, take up less room and save much assembly time. ▼▼▼

VALVE MANIFOLDS

CAST ALUMINUM FOR PNEUMATICS

Valvair Corporation

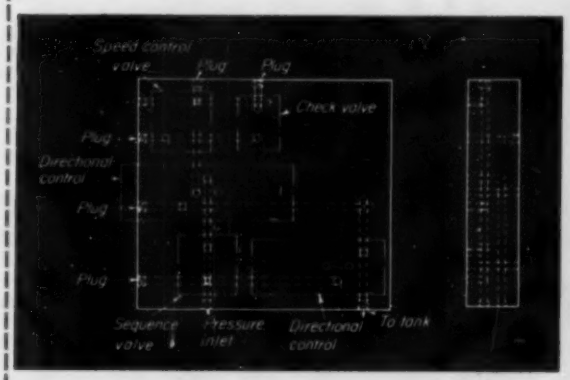
There's a definite trend toward manifolding air valves. The photo shows one design made from cast aluminum. Full length inlet and exhaust ports, both 1-inch NPT are common to all valve stations. Electrical wiring is run through a 1¼-inch NPT conduit passage, with one access cover for all stations to simplify wiring. Side or bottom cylinder porting can be provided to facilitate piping. Manifolds can be ganged by bolting the assemblies together end-to-end to allow uniform mounting of many valves. O-rings seal inlet, outlet and wiring ports.

DRILLED BLOCK

It is possible to run 45 gpm through the porting on a 2-inch thick manifold without too much pressure drop. A pipe tap of 1¼ inch can be used on the cross-sectional thickness of a 2-inch thick manifold. Drilled holes running parallel or across one another should not be closer than ¼ inch. Wherever possible a hole should be drilled from two sides to eliminate drill wandering. Long fluted drills are best suited for drilling deep holes. It is advisable to taper ream all pipe-tapped holes before tapping. The drilled manifold is ground on the mounting surface after all drilling has been completed. This eliminates a burring operation and gives an even surface for mounting valves.

It is good practice to make a drawing of each face of the manifold from which holes have to be drilled and to mark on the drawing the size and depth of each hole drilled from that face.

Since it is not always easy to visualize the three-dimensional network of passages, and any mistake could easily ruin the entire manifold, some method of checking the design is desirable. For very complex manifolds, plastic models have been used to check out the design.



Is Aluminum a Practical Material for Manifolds?

Good machinability, light weight and corrosion resistance are advantages which make the use of aluminum desirable for drilled manifolds. The one drawback has been the leakage problem. Barnes Drill, Rockford Machine Tool and Bullard are three machine tool builders using aluminum for drilled manifolds. Rockford is using 2, and 2½-inch plates. Aluminum pipe plugs solved a leakage problem existing with conventional plugs. Bullard uses a rolled aluminum plate 5 x 3½ feet which is 1¼ inch thick.

Because aluminum has a different coefficient of expansion from either steel or cast iron, an aluminum manifold must be located so that the resultant distortion from strain does not affect machine accuracy.

- **Pressures**—Successful applications of aluminum manifolds in the 2000-3000-psi range are reported. Cast aluminum manifolds have been pressure tested up to 6000 psi by Sundstrand.
- **Brazing Aluminum**—Monarch Machine Tool Company is using a brazed three-piece, sandwich type aluminum manifold in a lathe headstock. It is used at pressures in excess of 1200 psi. It is capable of withstanding 2200 psi. The assembly has a ¾-inch thick center plate and ⅜-inch thick outer plates. Aluminum manifolds as large as 12x36 inches and 15½ x 20 inches have been successfully brazed.

A relative newcomer in the field of hydraulic system components and materials seems to be well on its way to establishing itself as being worthy of the designer's consideration when selecting the material to be used in making up a circuit.

RESISTANCE-WELDED

ELECTRIC resistance welded tubing producers were called on to produce extremely large quantities of a special grade of cold worked tubing for a very critical ammunition component during the Korean conflict. Due to the extremely hazardous application, all such tubing was produced to meet the requirements of a very restrictive specification. Subsequently, it was found that by adding a full anneal (as a final operation) to this special grade of tubing, a product completely suitable for hydraulic line applications resulted. For the past four years

TABLE I—*Specification for Pressure*

Scope: This specification covers cold worked and annealed low carbon steel pressure tubing, produced by either electric resistance welding or by the seamless process.

Application: This material is intended for use in hydraulic lines for non-production applications or for applications requiring tubes of suitable quality for bending and flaring.

Workmanship: Finished tubes shall be reasonably straight and have smooth ends free from burrs. They shall be free from injurious defects and shall have a workmanlike finish. Surface defects caused by handling marks, straightening marks, light die marks, or shallow pits are not considered injurious defects providing the imperfections are removable within the tolerance specified for diameter and wall thickness. The removal of such surface imperfections is not required. There shall be no dimensional indication of welding flash in the case of electric resistance welded tubing.

Manufacture: The cold working shall result in minimum reduction of area of 15% of which at least 8% shall be reduction of wall thickness. The tubing shall be normalized prior to the cold working operation. After cold working the tubing shall be normalized or annealed.

Cleanliness: The inside of the tubing shall be commercially bright, clean and free from grease, drawing compounds, oxide scale, carbon deposits and any other contamination that cannot be readily removed by cleaning with alkaline cleaners or benzine. Tubing shall be shipped with ends suitably sealed to prevent contamination of interior.

Chemical Composition:

Carbon, %	0.18 max
Manganese, %	0.30-.60
Phosphorous, %	0.050 max
Sulfur, %	0.055 max

Dimensional Tolerances

Outside and Inside Diameter: The outside and inside diameter of the tubing shall not vary from that specified by more than the following amounts:

ELECTRIC RESISTANCE WELDED TUBING

Tube Size Outside Diameter Inches	Limits ± Inches OD	Inches ID
⅜	0.002	0.005
Over ⅜ to ⅝ incl.	0.0025	0.0025
Over ⅝ to 1⅛ incl.	0.003	0.003
Over 1⅛ to 2 incl.	0.003	0.003
Over 2 to 2½ incl.	0.004	0.004

SEAMLESS TUBING

Tube Size Outside Diameter Inches	Limits ± Inches OD	Inches ID
¼ to ½ incl.	0.003	
Over ½ to 1½ incl.	0.005	0.005
Over 1½ to 3½ incl.	0.010	0.010

Wall Thickness: When tubing is specified to the outside diameter and inside diameter, as shown, the wall thickness may vary in accordance with the permissible tolerances. When outside diameter, or inside diameter, and wall thickness of the tubes are specified, the outside diameter or inside diameter shall conform to the tolerances given and the wall thickness of the tube shall not vary more than plus or minus 10%.

For seamless tubing having an I.D. of less than ½", the outside diameter shall conform to the tolerance given in the table. The wall thickness shall not vary from that specified more than plus or minus 15%.

Physical Properties

Tensile and Elongation: The tubing shall conform to the following physical requirements:

Tensile Strength
Maximum 55,000 psi
Elongation in 2" Minimum 35%*

*For tubes with an O.D. of ⅜" and less and/or wall thickness of .035 and less, a minimum elongation of 30% is permitted.

Flattening Test: A section three inches (3") in length shall be taken from every shipment or every 1,500 feet of finished tubing, whichever is less. This sample shall be flattened between parallel plates to three times the wall thickness of the tube, without cracking or showing flaws. Superficial ruptures resulting from minor

HYDRAULIC TUBING

increasing quantities of this tubing have been used for hydraulic line applications.

There are three characteristics or properties of this grade of resistance welded tubing which make its use particularly attractive. These are: (1) Cost, (2) uniformity, (3) relative freedom from small surface defects or stress raisers which may cause failure under the vibration, pulsation, and surges present in hydraulic applications. These characteristics are inherent results of production and the grade of steel used. Therefore, a brief discussion of the process should be helpful.

HOW IT'S MADE

Initial step in production of tubing is forming flat-rolled, open-hearth, or electric-furnace steel of the proper grade into the required tubular shape. This is done by running the flat-rolled steel through a series of highly polished forming rolls. Since both surfaces of the flat steel may be checked prior

Tubing for Hydraulic Line Service

surface imperfections shall not be cause for rejection.

In the case of electric resistance welded tubing, for this test the weld shall be placed at a point 90 degrees from the direction of the applied force.

Reverse Flattening Test for Electric Resistance Welded Tubing: A section at least four inches in length shall be taken from every shipment or 1500 feet of finished tube and split longitudinally 90 degrees on each side of the weld. The sample shall be cut open and flattened with the weld at point of maximum bend. There shall be no evidence of cracks or lack of penetration or overlaps resulting from flash removal in the weld.

Expansion Test: A section at least 1½" in length shall be taken from each shipment or 1500 feet of tubing, whichever is less, and be subjected to an expansion over a polished plug until the outside diameter has been expanded 25%. The tubing shall be expanded the required amount throughout a minimum length of 1" along the axis of the tubing, without cracking or showing flaws. Superficial ruptures resulting from minor surface imperfections shall not be cause for rejection.

Tests for Pressure: Tubing supplied under this specification shall have been hydrostatically tested at a fiber stress of 20,000 psi or at an actual pressure of 5000 psi, whichever is less, based on the applicable minimum wall, or tested by use of a nondestructive test made in accordance with Specification MIL-T-17188.

Corrosion Protection of Interior of Tubes: The inside and outside of the tubing shall be protected by a coating of clean oil so as to protect the exterior and interior of the tube against corrosion during shipment and normal storage periods. The corrosion preventative oil used shall be such that after extended storage periods it can be readily removed with an alkaline solution or with benzine (Stoddard Solvent).

Pickle Brittleness: Tubing which has been pickled to remove scale shall be treated to eliminate pickle brittleness.

Length: Tubing shall be furnished in 17 to 24 feet selected mill lengths, unless otherwise specified on the purchase order.

Supplier's Responsibility: All material supplied to this specification must be equivalent in all characteristics to the material upon which approval was originally granted and shall be suitable for the intended application.

RECOMMENDED MINIMUM WALL THICKNESS (INCHES) FOR STEEL TUBING IN RELATION TO PRESSURE APPLICATION (PSI)

Tube Size Inches O.D.	Pressure Application—PSI			
	Low 0-200	Medium 200-500	Medium High 500-1200	High 1200-3000
⅛	.035	.035	.035	.060
3/16	.035	.035	.035	.060
¼	.035	.035	.035	.060
5/16	.035	.035	.035	.060
⅜	.035	.035	.035	.060
½	.035	.035	.035	.075
⅝	.035	.035	.049	.095
¾	.035	.035	.049	.109
⅞	.049	.049	.065	.109
1	.049	.049	.065	.120
1¼	.065	.065	.095	
1½	.065	.065	.095	

A brief discussion of the

FRANKLIN C. WOLFE COMPANY'S

Sealing Methods

Until recent years the two primary methods of static sealing were:

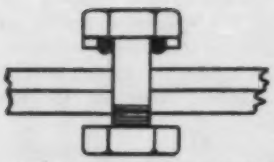
(1) Flat resilient gaskets, and (2) "0" ring-in-groove. As the need for more efficient no-leakage static sealing increased, a new method was sought to overcome disadvantages of these two methods.

For efficient, effective sealing the resilient flat gasket has an inherent weakness. To effect a seal the gasket must be displaced under pressure of faying surfaces. This means that the higher the internal pressures then the harder must be the gasket material and the thicker the flanges and the stronger the fasteners to accommodate the higher torques. That accumulation of adverse requirements mounts ad infinitum. In addition, a flat gasket exposes much surface to the action of the material (fluids, gases, etc.) against which it is sealing.

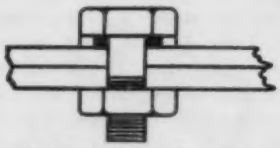
The "0" ring-in-groove method of sealing is more satisfactory for no-leakage sealing, but its principal drawbacks are high machining costs (all surfaces of groove and mating parts must be extremely smooth and flat), difficulty of placement and replacement (especially the latter). In an "0" ring-in-groove seal there are at least five critical dimensions, any one of which if out of tolerance may cause a leak. These tolerances may accumulate adversely too, rendering a seal impossible and causing discard of parts.

For many applications these two methods of sealing are satisfactory, but wherever zero-leakage sealing is required either for (1) Safety and/or Prevention of Malfunction; or

Franklin C. Wolf Company, Sealing Methods (continued)



Bolt (Typical) Before Fastening



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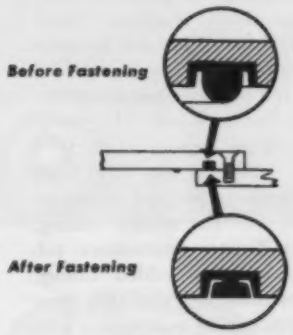
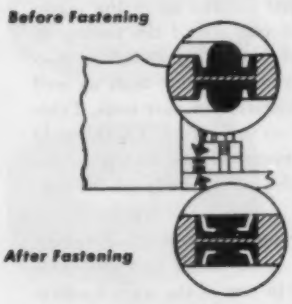


One Side Gask-O-Seal



Two Side Gask-O-Seal

(2) true Economy (to lower maintenance cost and prevent lost production time), then the disadvantages of flat gaskets and "O" ring-in-groove should be investigated

To overcome these disadvantages, the Franklin C. Wolfe Company has developed a method of sealing which is based upon the principle of controlled confinement of rubber (or compound with the physical properties of rubber). These seals:

1. ***Eliminate "Cold flow."***
2. ***Provide metal-to-metal contact of faying surfaces.***
3. ***Eliminate torque loss.***
4. ***Have a high re-usability factor.***
5. ***Are easy to install and replace.***
6. ***Do not require high fastening torques.***

They are made in many devices:

1. ***As fastener seals.***
2. ***As fittings seals.***
3. ***As flange, or flat surface seals.***
4. ***As wave-guide and electrical connector seals.***

Under torque, the rubber, or compound, is changed from a "round configuration to a square or oblong shape. Since rubber can not be appreciably compressed, it is simply deformed, but the "memory factor" of rubber is not destroyed under this pressure because a proper void to mass ratio has been predetermined and manufactured into the parts.

These seals are available in the devices shown. They come in many standard sizes and also are available as specials. They will seal both low and high pressures and against nearly all fuels and oils. In addition, seals are available as specials for nitric acid and many other highly corrosive fluids. The Gask-O-Seal can be made in almost any configuration to fit all requirements provided reasonable flat surfaces are used and sufficient land area is available to allow for seal. All of the seals are recommended in different call outs for temperatures as high as +350° (500° intermittent), and as low as −85° plus (F).

Recently our research department has developed a method of extreme temperature sealing in the range of 400° minus and over 1000° plus (F).

For static sealing problems, the company maintains a free consultation and design service and will gladly discuss any sealing problems. We recommend that this service especially be sought at the design stage so that proper application and avoidance of excess cost can be obtained.

FRANKLIN C. WOLFE CO.

A DIVISION OF THE PARKER APPLIANCE COMPANY

10567 Jefferson Blvd., Culver City, Calif.,

to and during the forming process, manufacturers of this tubing point out that this makes possible the avoidance of surface imperfections both on exterior and interior surfaces of the tubing.

Next step in the continuous production process is the welding operation. Here the edges of the formed tube are brought together under pressure and continuously welded without adding any extra metal. To meet the "reverse flattening" requirement of the specification (which is similar to ASTM: A-178 and A-214) the outside and inside welding flash is customarily removed by cutting or scarfing before further processing. The tubing is then normalized (which gives complete recrystallization of the weld area) before cold working. The specification requires that this cold working result in a minimum reduction of both area and wall thickness of the tubing.

As a direct result of the production process, welded tubing possesses a high degree of uniformity insofar as diameter, wall thickness, strength and workability are concerned. All of these properties are extremely important in hydraulic applications.

IS IT FULLY APPROVED?

Actual application of the product in various types of high pressure systems has proved it highly satisfactory. Also considerable testing in laboratories and installation have borne out that it surpasses the requirements of the system and materials previously used. In spite of the relative newness of this product, many industrial concerns have approved the product and either adopted the specification or written a similar one. General approval such as JIC and SAE is under consideration and action seems imminent.

A tentative SAE specification has been issued and is now being circulated among members of the SAE Tube, Pipe, Hose and Lubricating committee for approval or their suggested modifications or revisions. According to one of the members of this committee, there is no doubt that resistance-welded tubing is highly suitable for use in hydraulic circuits. He states, "It's simply a matter of having a properly written specification so that the tubing will be of the quality required for hydraulics use."

Two of the largest automobile manufacturers have done considerable testing of this type of tubing and one of them has rewritten its specification for hydraulic tubing on the strength of rigorous tests, Table 1. The other manufacturer has established a specification for welded tubing for use on production hydraulic equipment which is nearly identical with that in Table 1. A comparison of these specifications and previous specifications produces some points worthy of comment. There is very little difference between the specification covering welded tubing and previous specifications. These differences are: (1) Specification of the location of the weld for the flattening test, (2) A reverse flattening test and an expansion test for the welded tubing, and (3) Tighter dimensional tolerances for the welded tubing. This last illustrates that very close tolerances can be maintained with this tubing. The first two points are a reflection of the skepticism which has existed as to the possibility of rupture of the tubing at the weld. However, the tubing successfully passes these tests as well as hydrostatic pressure tests, Table 2, with no indication that the weld is not every bit as strong as the remainder of the body of the tubing.

- **Formability**—Welded tubing can be bent, flared and otherwise formed in any of the ways hydraulic tubing is usually handled. Its uniform wall thickness and high concentricity are said to result in very uniform flaring properties which are highly desirable.

- **Ordering**—Persons who have had some experience with welded tubing for hydraulic use feel that a fairly complete specification should be issued the supplier when this type of tubing is ordered. A specification such as that in Table 1 is recommended. ▼▼▼

TABLE 2

Bend, Flare and Hydrostatic Test Results*

Type of Tube	Relation, Weld to Bends	Sample No.	Max. Pressure PSI	Location of Failure Displacement From Weld	Location of Failure Distance From Center of Bend
Annealed	Outside & Inside of Bends	1	9,000	90°	11"
	" "	2	9,300	0°	3"
	" "	3	9,100	90°	8"
	" "	4	9,000	0°	8"
	" "	5	9,000	60°	3"
	" "	6	9,000	140°	8"
	Side of Bends	7	9,000	0°	9"
	" " "	8	9,000	0°	7"
Heat Treated	Outside & Inside of Bends	1	9,500	0°	9"
	" "	2	10,200	180°	8"
	" "	3	9,500	180°	3"
	" "	4	9,900	30°	8"
	" "	5	9,500	180°	6"
	" "	6	10,000	180°	3"
	Side of Bends	7	9,500	45°	5"

*For these tests, made by one of the largest U. S. automobile manufacturers, 22" lengths of each type tube were successively bent, flared, and hydrostatic tested in the following manner: Two 90° bends were made in each tube length around a cylindrical mandrel of 3½" diameter. The 90° bends were in the same plane, but in opposite directions on all pieces. Location of the weld with respect to the bend is noted in the data. Both ends of the tube were then flared with a flaring tool of the type used by the company maintenance departments. After assembly with proper flare type fittings, the tube was hydrostatic tested to failure.

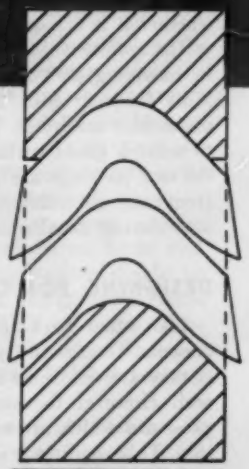
The Biggest Package in Packings!

EXTRUSION-PROOF ADAPTORS

Periflex "Phenol-Fab" bearing type adaptors prevent extrusion and reduce machining costs by providing bearing surface where tolerance on parts is not held closely.

PRELOADED PRESSURE RINGS

Periflex molded duck and neoprene pressure rings with flared lips preload the packing recess without gland pressure and are endlessly molded.



Longer packing life and greater operating efficiency are both assured with this Periflex assembly widely used as rod or piston seal and preferred for proved ability to withstand high pressures and severe operating conditions.

Periflex • Inc.

Write for "V"-Ring data sheets.

HAZEL PARK
MICHIGAN

Selecting the right packing for the job is the first step in controlling leakage in cylinders, valves, and piping. The second step—and just as important—is making the right packing installation. Here are recommended design and maintenance practices showing . . .

HOW TO INSTALL

INSTALLING packings is a job for both the designer and the maintenance man. The designer must lay out the proper size and shape of the seal enclosure. He must specify the right surface finish, and he must be careful to avoid designs which pinch the packing, cut it on sharp edges, or deform it more than necessary. The designer must consider the fluid and pressure he is working with—the material and shape of the packing he has selected. He must consider the *type* of seal he is designing—whether it is a moving or stationary application.

The maintenance man also has an important part in installing packings, because this is one of his most frequent jobs in caring for hydraulic and pneumatic machines. He must use great care not to scratch gland surfaces; he must be certain that the new packings are properly seated; and he must frequently use techniques to prevent damaging packings during installation.

DESIGNING FOR O-RINGS

Like other packings used in fluid power components, O-rings are *pressure-energized* seals—that is they are deformed by pressure to form a tighter seal. However the seal must also be effective at pressures which are too low to make this deformation. This requires a squeeze or interference on the seal. The amount of this squeeze varies with the O-ring cross section diameter, and recommended values are given in manufacturer's literature. This information is included with groove dimensions for static seals and for moving seals with and without roll.

The recommended groove depth and clearance dimensions are designed to produce a squeeze under all conditions of tolerances, clearances, eccentricities, side-loads, and linear contraction at low temperatures. Decreasing the squeeze can slightly reduce the running friction of moving seals, but it may result in leakage at low pressures and temperatures. Increasing the squeeze makes assembly more difficult, shortens the life of moving seals and slightly increases the running friction.

Grooves with straight sides are recommended, although for non-critical applications the wall may slope as much as 5 degrees. The corners should be broken.

For moving seal installations where the O-ring rolls in the groove, the groove length is approximately 50% more than the O-ring nominal cross section diameter. This usually compensates for swell of the O-ring as well as permitting the seal to roll back and forth in the groove with the reciprocation of the unit.

Ordinarily O-rings should permit a leakage of not more than a few drops per 1000 strokes. However rapid stroking may cause excessive leakage in

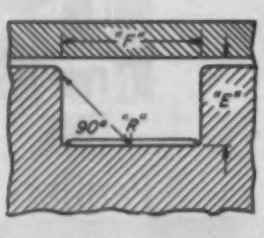


TABLE 1—Moving O-ring Groove Dimensions

O-Ring Nominal Cross Section-in.	O-Ring Cross-Section-in.	"E" Max. Gland Width-in. +.000 —.002	Minimum Diametral Squeeze-in.	"F" Groove Length-in. +.005 —.000	"R" Bottom Radius-in.
1/16	.070 ± .003	.057	.010	3/32	1/64
3/32	.103 ± .003	.090	.010	9/64	1/64
1/8	.139 ± .004	.123	.012	3/16	1/32
3/16	.210 ± .005	.188	.017	9/32	1/32
1/4	.275 ± .006	.240	.029	3/8	1/16

A PACKING

. . . on air and oil powered equipment

rolling O-ring installations because of the O-ring acting as a pump each time it rolls. Leakage can also be caused by severe surge pressures. These causes can be corrected by using a harder compound to reduce distortion of the O-ring and by using a rougher groove surface to reduce rolling.

Designing the groove to eliminate rolling completely will also help to reduce leakage, but will also increase friction and packing wear. Grooves for non-rolling seals allow about 15% of the O-ring cross section diameter for swell. If the particular fluid and seal compound will produce a swell of more than 15%, the groove length must be increased to avoid binding, excessive wear, and extrusion.

Groove length for static seals is not usually critical except in applications where there are rapidly pulsating pressures. If the groove is too long, these pulsations may cause movement and wear of the O-ring. Some manufacturers recommend a smaller groove length for these applications.

Clearances between the surfaces sealed by an O-ring should be as close as manufacturing methods will permit. In determining these clearances the designer must take into account the differential coefficients of expansion of the metals, so that there will be no binding throughout the temperature range of the system. This clearance is a factor in extrusion of the O-ring and this extrusion in turn causes seal wear and friction. The hardness of the O-ring is also a factor in extrusion.

A durometer hardness of 70 has been recommended for pressures to 1500 psi, 80 durometer to 2500 psi and 90 durometer for all higher pressures.

For clearances larger than those recommended, back-up rings of thin metal, bakelite, leather, or Teflon are used. Leather back-up rings have the advantage of absorbing oil and helping to lubricate the seal. The Teflon rings offer simple installation and low friction.

When designing a back-up ring installation, the expansion of members under pressure should be considered. This expansion can provide a clearance which will permit extrusion in spite of the back-up rings. It is recommended that back-up rings be used on all medium and large pistons and rods where close clearance gaps are required.

The O-ring groove should have a good machine surface and should be free of burrs, nicks and scratches. Finish of the moving surface should be 16 micro-inches RMS or better, and groove surfaces should be 32 micro inches RMS or better. Surface finishes of the groove sides should be 32 micro inches RMS, or 63 micro inches RMS if back-up rings are used.

When designing moving O-ring installations, if possible the groove should be located on the shaft instead of the bore because of the relative simplicity of machining the groove and installing the O-ring on the shaft. When a moving seal is required to pass over a hole or other opening in the bore, a chamfer of 10 to 20 degrees should be provided so that the O-ring is not pinched or cut by a sharp edge.

A recent design for O-ring installations has been the "floating gland" which eliminates squeeze. This increases the life of the seal and reduces friction. It is primarily intended for compressed air service,

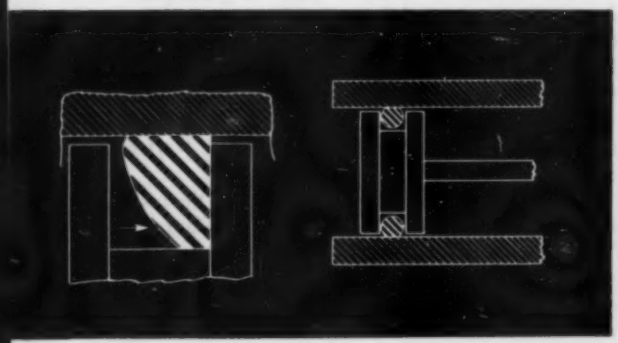
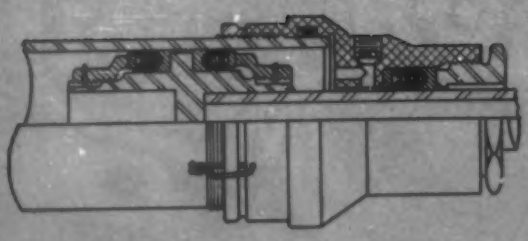


FIG. 1. FLOATING O-RING DESIGN. O-ring OD is larger than cylinder bore, forming sufficient squeeze for pneumatic applications and some hydraulic applications.



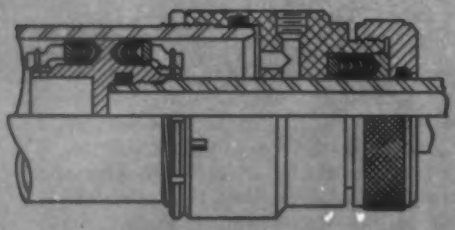
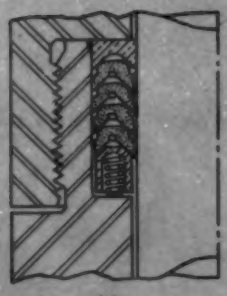
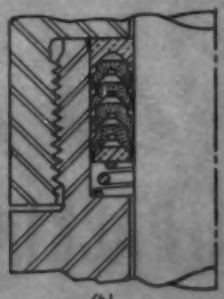


FIG. 2. TWO TYPICAL DESIGNS for V-ring packing on cylinder rod and piston.





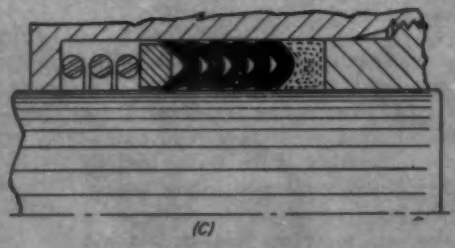


FIG. 3. SPRING-LOADED V-RING designs. Spring loading produces a more uniform breakout friction, lower running friction, and longer and more predictable life. (a) and (b) show reinforced V-ring installations. (c) is a homogenous V-ring installation.

although it can be used for hydraulic applications where some leakage can be tolerated when the pressure is initially applied. The design is illustrated in Figure 1, and it should be noted that the O-ring OD is larger than the bore of the cylinder. This presses the O-ring against the bore and accomplishes the same thing as conventional squeeze. Groove length should be equal to the maximum O-ring cross section diameter plus 10% of the mean O-ring cross section diameter.

The groove length of the floating design is shorter and more critical, but the design permits larger tolerances in cylinder bore diameters, piston groove root diameters, rod groove root diameters, and gland widths.

Normally one O-ring is sufficient for each seal, and the use of more than one can cause pressure traps between the seals when hydraulic fluid or air system lubricant is trapped between the O-rings. If the use of more than one O-ring is required for some design reason, some provision must be made to vent the area between them.

DESIGNING FOR V-RINGS

V-rings are most frequently used for piston and rod seals in cylinders. Two typical designs for this application are shown in Figure 2. They are available in homogeneous synthetic rubber compound, reinforced rubber, and leather. Each type has a different cross section design and requires a different enclosure.

V-rings depend upon compression of the lips for sealing at low pressures, and in designing the installation, the V-ring should not be required to pass over holes, corners, or ports which would leave the ring unrestrained.

An important part of the V-ring installation is the female adapter, and much of the success of the seal installation depends upon this unit. The design of this adapter depends on the type of V-ring used, and dimensions are given in manufacturer's literature. Fabric reinforced adapters can be supplied for pressures to 3000 psi if metal adapters are not desirable.

Solid (non-split) V-rings require no gland pressure and the gland follower ring can be spaced by shims and screwed up metal-to-metal. On packings which have a scarfed cut to facilitate installation, no gland pressure is required to effect a seal in the packings themselves. However, light gland pressure is usually required to seal the scarfed joints.

If space permits, it is recommended that the male adapter be spring loaded as shown in Figure 3. This establishes the correct adjustment and makes overtightening or under-tightening of the gland closure impossible. Spring-loaded assemblies have a more uniform breakout friction, lower running

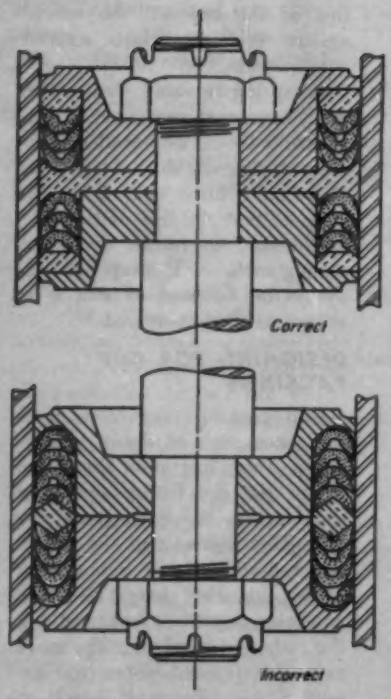


FIG. 4. V-RINGS SHOULD BE INSTALLED on double acting pistons, so that the pistons face away from each other. Female adapters should be rigidly mounted and not supported by the opposite V-ring stack.

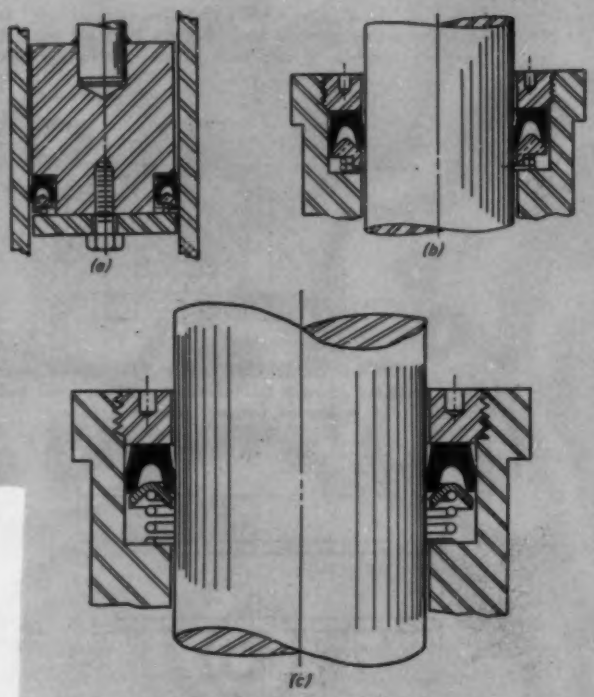


FIG. 5. SPRING-LOADED DESIGNS for U-rings. This insures proper lip contact without overtightening.

friction, and a longer and more predictable life. Information on designing spring-loaded installations is available from seal manufacturers.

The life of the V-ring is a direct function of the finish of the surface moving against it. Moving surfaces such as cylinder bores and rods against which the V-rings must bear should have a minimum surface finish of 16 micro-inches RMS. The static surface against which the V-ring bears should have a minimum surface finish of 32 micro-inches RMS.

On piston installations of double acting cylinders where the pressure is exerted in both directions, the V-rings should be installed so that the sealing lips face away from each other. Correct and incorrect methods are shown in Figure 4. The female adapters should be mounted rigidly so that they are not supported by the other set of V-rings.

DESIGNING FOR U-RINGS

Like V-rings, U-rings depend upon contact made by their flexible lips for sealing, and are slightly preloaded when installed. U-rings have low friction and permit wide variations in gland dimensions. They have been successfully used to eliminate excessive packing friction at low pressures without narrow gland tolerances.

If space permits, the U-ring should be spring loaded as shown in Figure 5. This insures that the

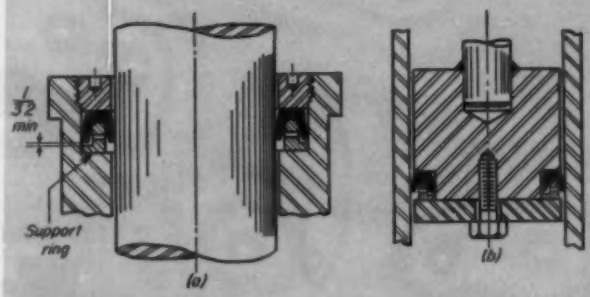


FIG. 6. SUPPORT RING can be used when space limitations or other considerations prevent using springs. Support should not exert appreciable force against U-ring, and its design should insure centering.

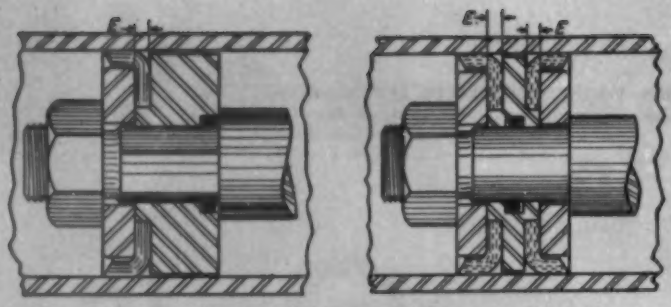


FIG. 7. CUP PACKING installed on single and double acting piston. Shoulder on back-up plate insures centering of cup and proper clamping force.

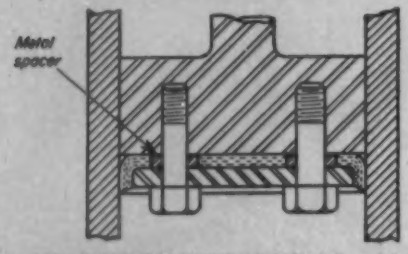


FIG. 8. ON 4-INCH DIAMETER PISTONS and larger, cup packing should be installed with several bolts. Metal spacers insure proper clamping force.

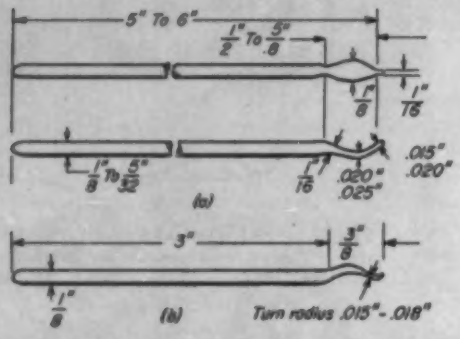


FIG. 9. TOOLS FOR REMOVING O-RINGS. Tool shown in (a) is for removing seals from external grooves. Tool shown in (b) is for removing seals from internal grooves.

lips of the cup will be spread against sealing surface without overtightening.

If spring loading cannot be used, a support ring as shown in Figure 6 should be installed. This support ring should not exert an appreciable force against the U-ring, so that the lips of the ring would tend to retract from the sealing surfaces. The support ring should be designed so that it is always properly centered.

DESIGNING FOR CUP PACKINGS

Cup packings are often used for piston seals as shown in Figure 7. This illustration shows the ID of the cup fitting against a shoulder on the supporting section. This insures that the cup is centered with proper compression of the cup. This design also uses an O-ring to prevent leakage along the rod, and eliminates the more expensive tapered piston rod assembly. For pistons of 4-inch or larger diameter, several bolts should be used as shown in Figure 8. The back-up plate should be flat to prevent deformation of the cup packing or extrusion at the heel. The metal spacers insure proper clamping force on the packing.

MAINTENANCE

Many leakage problems begin when old seals are improperly removed or new seals badly installed. The installation should be carefully examined while removing the seals. Excessive leakage

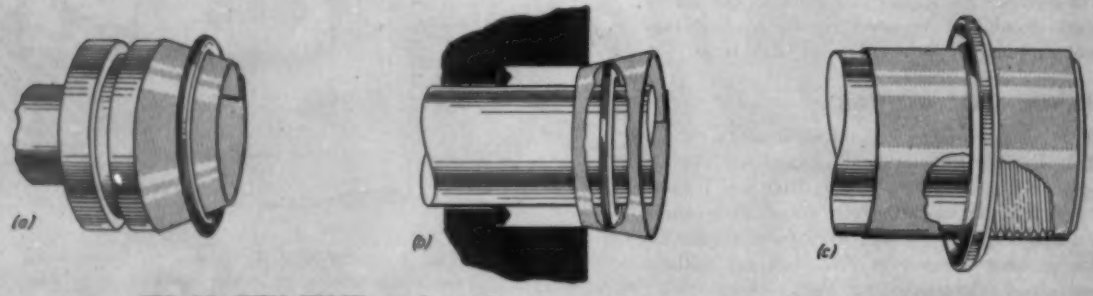


FIG. 10. SHIM STOCK can be used to prevent damage to seals during installation. (a) shows installation of O-ring past sharp corner of piston. (b) shows protection of V-ring from sharp edge of gland. (c) indicates method of installing seals on piston rod which has threads that have not been undercut.

might be the result of lack of lubrication, dirt, or scratches on the sealing faces, and these can be remedied at the time the seal is changed.

Usually some type of flexible shaft auger or special tool is required for removing seals. Figure 9 shows special tools for removing O-rings. Special care must be used to avoid scratching groove and gland surfaces, because these scratches can cause seal wear and leakage. Scratches on a piston rod can usually be stoned out and polished with fine crocus cloth. When installing piston rod packing, the piston rod should not be all the way out. If it is scratched by accident, it can then be extended further to remove the scratch.

Before new seals are installed, the groove or gland and the seal should be thoroughly cleaned and lubricated with the hydraulic fluid of the system. In pneumatic systems O-ring grooves should be filled with high melting-point grease such as barium or lithium soap grease. Special silicone greases are made for aircraft pneumatic systems. In some applications, felt rings saturated with oil are installed in separate grooves on both sides of the O-ring.

When installing V-rings each ring is positioned separately making sure of proper seating. A wooden stick with a *V* cut in one end is a convenient tool for seating the V-rings. With solid packings there is a tendency for air to collect under the rings when they are installed. This can be prevented by inserting a thin, soft-metal rod between the seal and gland to collapse the seal lip.

When installing split seals the joints should be staggered alternately 180 degrees and then 90 degrees. The surfaces of the joint should overlap slightly and should not be cut. Split rings should not be used with rotary applications.

Leakage can be caused by scuffing the seal during installation, and care must be taken to protect it from square shoulders, piston rod threads, and other projections over which it must pass during installation. This is particularly important with solid seals which must be stretched slightly during installation. ▼▼▼

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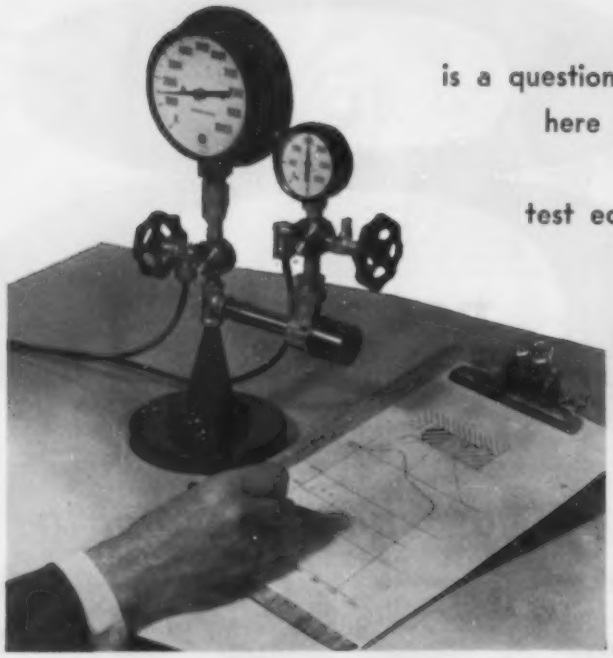

Just how a packing works is a question often left to the theorists. But here is how one company found out by using an original design of test equipment and showing that . . .

PRESSURE DROP ACROSS A PACKING

. . . tells the sealing story

• By Edward M. May

IN developing a swivel joint, one of the major considerations was how to design the packing. Where does the sealing actually take place—across the O-ring or across the back-up ring? How many V-rings are really necessary? What is the effect of slight modifications to seals for rotating shafts? These questions could only be answered by examining the conditions along the length of the packing.

Pressure is a good indicator of sealing characteristics, so a test set-up was required to measure pressure along the sealing path of various types of packings. There being no known precedents, the first thought was to make a hole in a shaft and measure the pressure at various points along the contact of the packing with the shaft. However, it seemed logical that any hole that could be drilled would probably plug with the packing and make any measurements impossible.

It was then decided that the required measurements might be made by using a shaft with a 0.002-in. wide slot and introducing controlled pressure into the slot to balance the pressure exerted by the packing. Then the amount of pressure necessary at the slot to force the seal off the shaft and cause leakage should represent very closely the pressure which was exerted against the shaft by the packing. Since this was the heart of the apparatus, further tests were made with an arbor having a pressure slot and an exhaust slot separated by a wall only 0.005 in. thick. Pressure readings were substantially the same as with the single slot. This substantiated the original deduction that these readings are packing pressures on the shaft at the successive locations of the slot.

Rather than attempt to cut a 0.002-in. wide slot in a shaft, a two-piece arbor, Figure 1, was made and the two pieces drawn together until the 0.002-in. gap existed between the two. A micrometer adjustment was also incorporated in the device to permit the packing to be moved across the slot so that measurements might be taken at various points.

To make the measurements, the shaft was connected as shown in Figure 2. Air, gas or oil was admitted through valve No. 1 to the slot and its pressure indicated on the "Pressure Drop" gage. Pressure was also admitted to the packing space and indicated on the "System Pressure" gage.

Initial experiments with this device showed that there was no essential difference in results when

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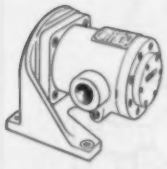

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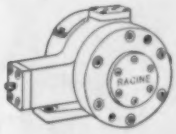

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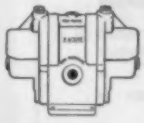

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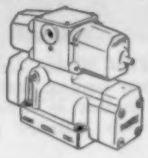

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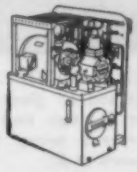

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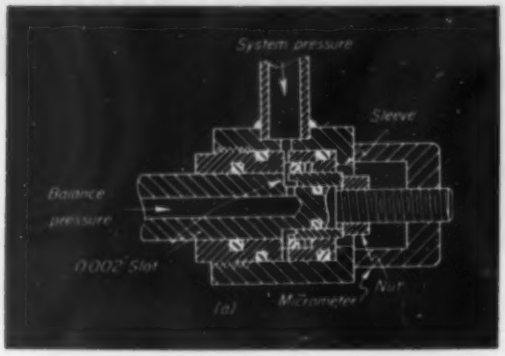
oil, air or water were used as the pressure medium. Therefore, dry nitrogen was settled upon as the most convenient medium.

• **Test Procedure**—First step in actual testing was to find the point at which the packing first contacted the shaft or sealed the slot. This was done by pressurizing the system, then shutting off the tank and cracking the flare nut between valve No. 1 and the pressure tank. Cracking Valve No. 1 slightly then allowed pressure to drop on both gages. The micrometer was then rapidly advanced until the system pressure gage stopped dropping.



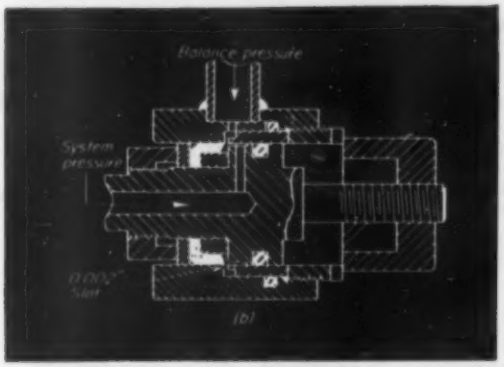


FIG. 1. DEVICES USED FOR MEASURING pressure exerted by packings against sealing surfaces. Setup for O-rings and similar devices is shown at *a*. A reversed setup for use with cylinder packings is shown at *b*.

FIG. 2. THE TEST PRESSURE SOURCE, in this case a nitrogen bottle, is connected through valve No. 1. Pressure on the slot side of the packing is shown on the "Pressure Drop" gage. Pressure on the other side of the packing is shown on the "System Pressure" gage. The accumulator maintains even system pressure. Valve No. 2 is also used to maintain even system pressure by venting if the pressure becomes excessive.

This meant the packing had sealed the slot. The flare nut was then retightened and pressure admitted through valve No. 1 to bring system pressure to the desired level. The accumulator in the circuit served only to maintain even system pressure. Measurement then proceeded in 0.010-in. increments or as small as 0.001-in. increments depending upon the rate of pressure drop. Valve No. 2 was opened when necessary to bleed off excessive pressure and maintain system pressure constant. This was its only function in the circuit.

• **Tests**—First packing tested was an O-ring which resulted in the curve shown in Figure 3. Next an O-ring and back-up ring were tested, Figure 4. Apparently the grain or hair side of the leather was sealing very well while the more porous flesh side leaked above 1300 psi. This seemed interesting so it was decided to attempt to correlate this with wear. The packing was mounted on a soft steel shaft, filled to 2500-psi oil pressure and run at 200 rpm. It had to be cooled with water to keep the temperature down and was squealing in 20 minutes. Examination showed a narrow scored band on the shaft and metal embedded at the juncture of the grain and flesh layers. This seemed to demonstrate relationship between packing failure and rate of pressure drop across the packing.

Re-examination of the pressure drop chart showed that the pressure drop rate was 240,000 psi per in. for this particular region of the packing. Based upon these figures any lubricant film between the shaft and the packing would have been under a shear stress far exceeding that of most metals. It certainly seemed that this pressure drop rate or PDR was a useful quantity for determining comparative efficiency of packings and mountings.

In an attempt to obtain more useful data, pressure drop tests were run on other packings and

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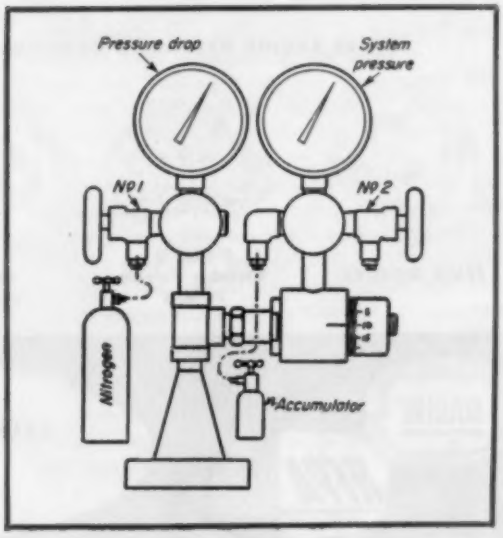

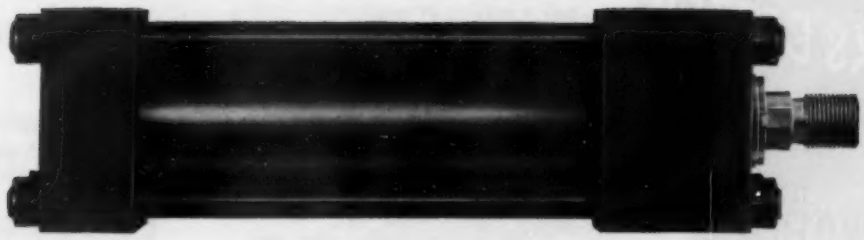

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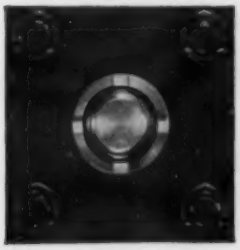

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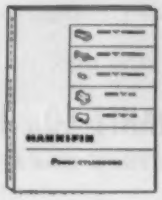

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PRESSURE DROP ACROSS A PACKING

Concluded from page 112

wear tests were also conducted. Tests on an O-ring and oil-tanned leather back-up ring showed that when first installed, the O-ring had a sealing pressure well above 3000 psi when system pressure was 3000 psi; while the back-up ring would not seal over 2000 psi. At 500 psi, almost all the pressure drop was across the back-up ring. After some use, the leather was glazed and compacted and sealed well at 3000 psi but leaked at 500 psi. The O-ring still sealed well and showed no wear at this time although the corner of the leather was frayed. After considerably more wear the O-ring continued to seal at 3000 psi but the leather would not hold pressure at all. At the same time the joint leaked very badly at 500 psi system pressure.

Tests on three V-ring packings versus a single ring showed that as far as the ultimate pressure which could be sealed was concerned there was no difference. A comparison of the two cross-sections available in O-rings for use with ¾-in. shafts showed no particular advantage for the heavier cross-section ring.

Despite the fascinating aspects of this investigation, it was felt that sufficient knowledge had been gained to permit solution of the original problem. Eight different shapes of gland rings were quickly evaluated to determine which gave lowest PDR. The swivel joint constructed met all tests with flying colors.

• **Conclusions**—Data collected so far on PDR and its effect on packing life are far too meager to permit any far-reaching pronouncements as to ideal shape of the pressure drop curve or its effect upon packing life for a variety of materials and operating conditions. However, it appears that a thorough investigation along these lines might lead to some very useful criteria for evaluating packing life and performance. ▼▼▼

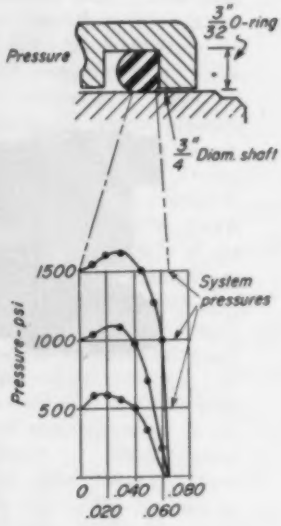

FIG. 3. RESULTS OF PRESSURE MEASUREMENTS with a 3/32-in. diam. O-ring. Variation of pressure drop is as might be expected and varies in relatively uniform manner.

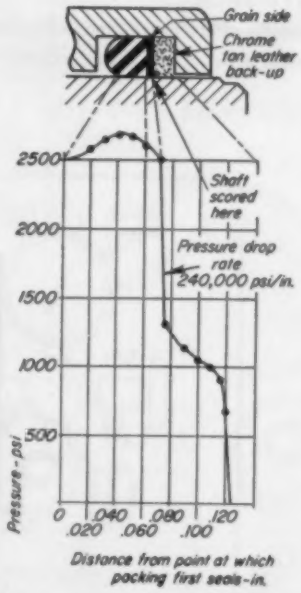

FIG. 4. WHEN AN O-RING and back-up ring were tested, a very high pressure drop rate was found at the juncture of the grain and flesh sides of the back-up ring. A subsequent operating test showed a very rapid wear rate at this point.

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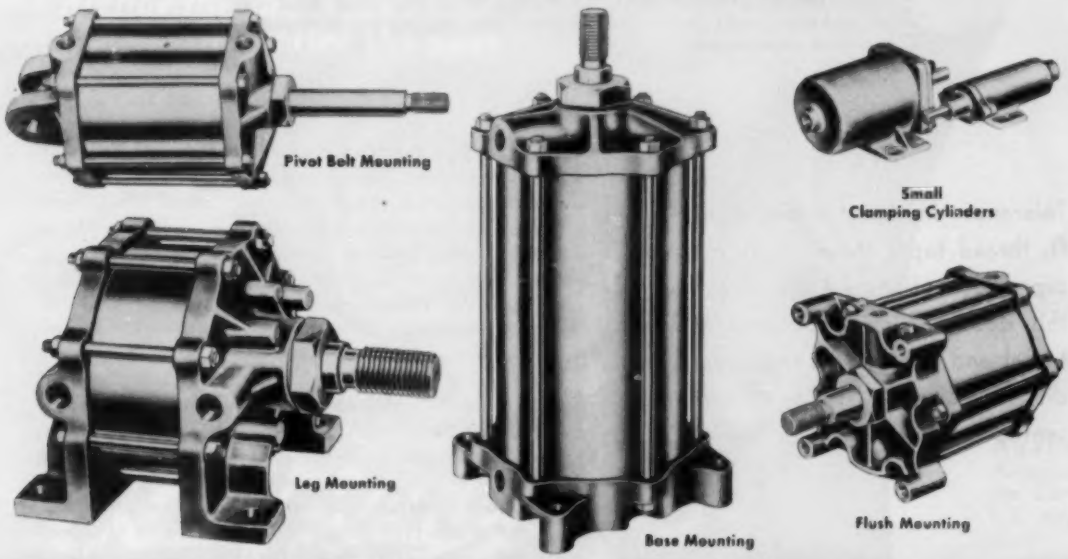

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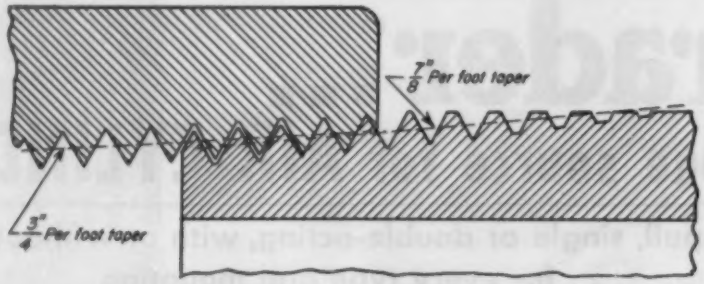

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PIPE THREAD LEAKAGE

This article is based on a paper delivered by Douglas M. McConnell of Vickers Inc. at the 1951 National Conference on Industrial Hydraulics.

TAPERED pipe threads have been widely used for many years to connect piping and components of medium and high-pressure hydraulic systems. Cost of this type of hydraulic connection is relatively low and assembly is simple. Results, however, are not entirely satisfactory because a number of joints made by this method leak after assembly. This requires that the joint be disassembled and reworked. Disassembly and rework increase machine building time and, of course, costs.

Reasons for this leakage with the American National pipe thread form which uses equal taper for both internal and external threads are imperfections in thread shape, or form, and finish which are unavoidable when working to practical production tolerances. Analysis of the possible fits due to tolerance variations shows that practically all joints of this type should leak. Interference of thread roots and crests before thread flanks contact would leave a helical leakage path along the flanks. Interference of flanks before crests and roots contact would leave a leakage path along the thread crests.

The reason that practically all tapered pipe threads do not leak because of these variations is attributed to tolerance variations on the taper. Because of taper tolerances, either the internal or external thread will have more or less taper than the other, as a rule. This deviation in taper results in a very high radial load on only a few threads, from the tightening torque. Without this variation, the load would be uniformly distributed over all the threads in contact. With the load on only a few threads, these threads are cold worked or reformed during tightening to give perfect contact and a good seal. It is generally recognized that only 1½ threads in perfect contact of this sort will give a good seal.

• **Testing**—To test the possibility of applying this reasoning to obtain a good seal every time, tests were run using plugs with an external taper of 7/8 in. per ft. with standard internal threads with a taper of 3/4 in. per ft. As a control standard plugs were also used. The special plugs were dimensioned so that the pitch line of the external thread intersected the pitch line of the internal thread in the second full thread from the large end of the plug and the first full thread from the large end of the hole.

Continued on page 118

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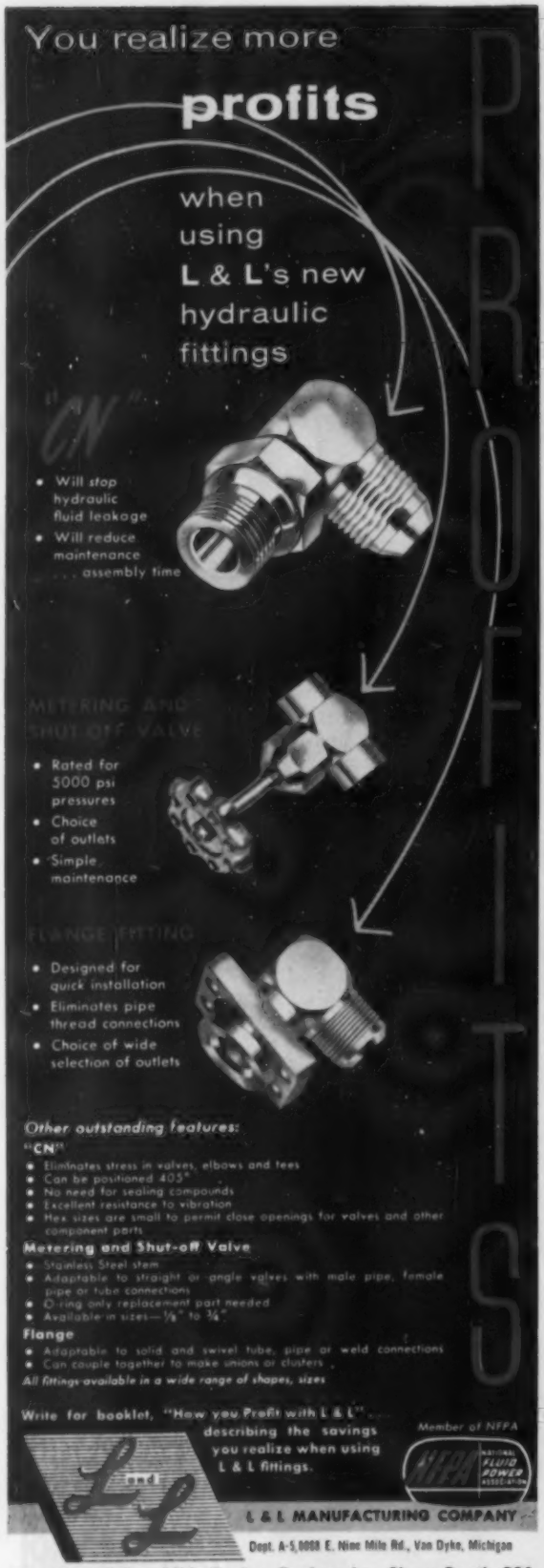
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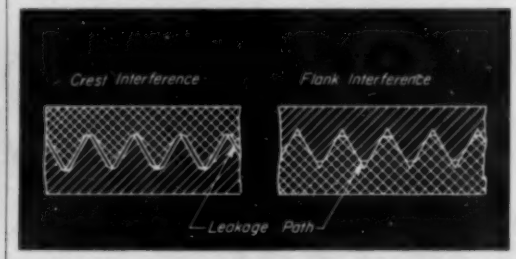
PIPE THREAD LEAKAGE

Concluded from page 116

In production assembly, using regular personnel and standard procedures, 50 plugs in ⅜-in. and ¾-in. sizes were assembled. An equal number of standard plugs of both sizes were also assembled in the same way. On test at 1500 psi, six of the standard ¾-in. plugs leaked and had to be disassembled and reworked. None of the special taper plugs leaked. In the ⅜-in. size, six of 50 standard plugs leaked and one of the special plugs leaked. Female threads were imperfect in this case, due to casting porosity.

Some additional tests under production conditions produced other interesting results. In 46 cases where a leaking standard plug was replaced with one of the special plugs, leakage stopped in 45 instances. When the special plugs were taken out and the standard plugs reinstalled, leakage was stopped in 38 of these cases. It is felt that this improvement in sealing properties is the result of burnishing or reshaping of the internal threads. This suggests that a burnishing operation should follow tapping.



TOLERANCES of normal pipe threads make leakage along flanks or crests of threads possible.

• **High Pressure Performance**—To obtain some idea of the performance of these threads at higher pressures, four test blocks to withstand 10,000 psi were prepared. Two blocks were of cast iron; the other two were SAE 1020 steel. One block of each material was tapped on a standard tapping machine with four ⅜-in. holes. The other two blocks were tapped with ¾-in. holes. Special taper plugs were then installed in all the holes using 80 lb-ft torque for the ⅜-in. size and 200 lb-ft for the ¾-in. size. Test fluid used was AN-0-7 hydraulic oil. This is a special test oil with very low viscosity. All of the plugs sealed tightly after 15 minutes at 7000 psi. This pressure was reached in 1000-psi steps with a dwell of 5 minutes at each pressure.

After 15 minutes at 7000 psi, the plugs were loosened. The ¾-in. plugs were then re-tightened to 100 lb-ft and the ⅜-in. size to 50 lb-ft. The test procedure was then repeated. At 7000 psi, one of the ¾-in. plugs in the cast iron block showed a slight leak. The plug sealed again when torque was increased to 150 lb-ft.

Although the scope of these tests is somewhat limited, it does seem that there may be merit to modifying external pipe threads in this fashion for use in systems at up to 5000 psi. ▼▼▼

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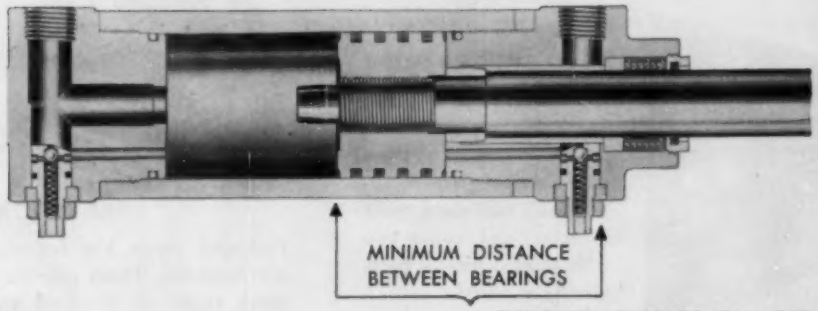

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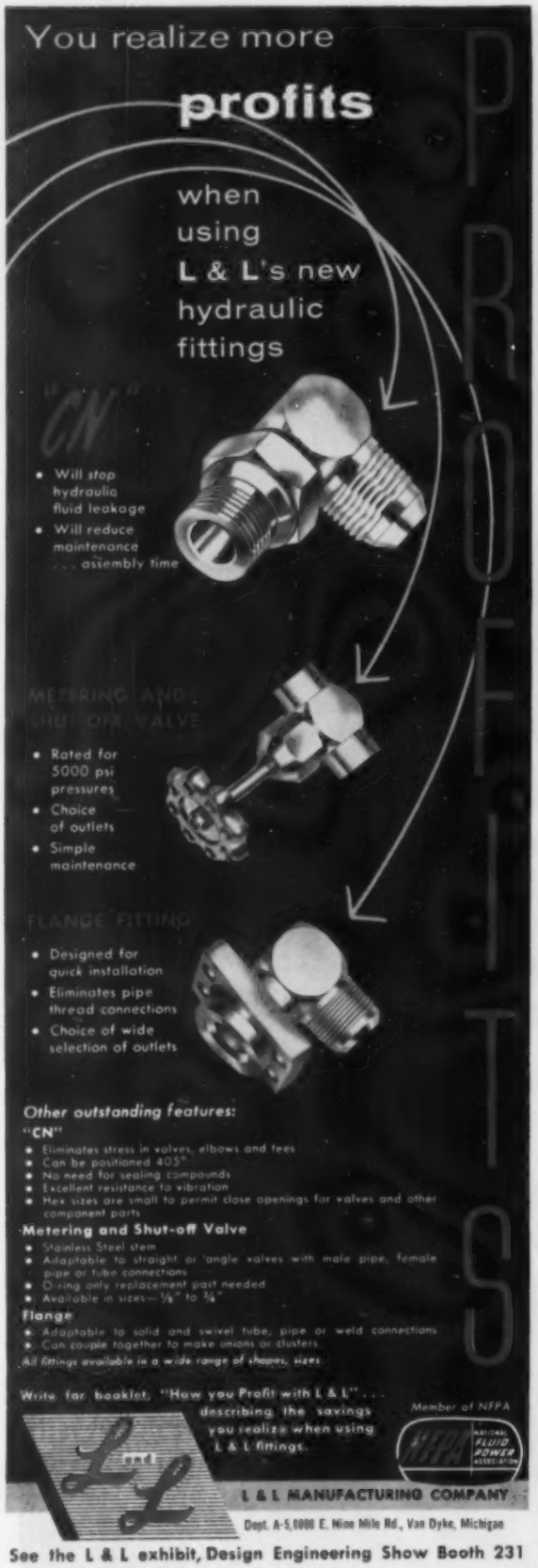
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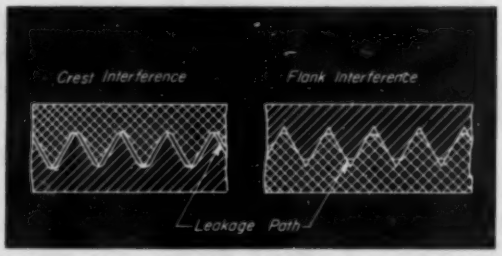

TOLERANCES of normal pipe threads make leakage along flanks or crests of threads possible.

• **High Pressure Performance**—To obtain some idea of the performance of these threads at higher pressures, four test blocks to withstand 10,000 psi were prepared. Two blocks were of cast iron; the other two were SAE 1020 steel. One block of each material was tapped on a standard tapping machine with four ⅜-in. holes. The other two blocks were tapped with ¾-in. holes. Special taper plugs were then installed in all the holes using 80 lb-ft torque for the ⅜-in. size and 200 lb-ft for the ¾-in. size. Test fluid used was AN-0-7 hydraulic oil. This is a special test oil with very low viscosity. All of the plugs sealed tightly after 15 minutes at 7000 psi. This pressure was reached in 1000-psi steps with a dwell of 5 minutes at each pressure.

After 15 minutes at 7000 psi, the plugs were loosened. The ¾-in. plugs were then re-tightened to 100 lb-ft and the ⅜-in. size to 50 lb-ft. The test procedure was then repeated. At 7000 psi, one of the ¾-in. plugs in the cast iron block showed a slight leak. The plug sealed again when torque was increased to 150 lb-ft.

Although the scope of these tests is somewhat limited, it does seem that there may be merit to modifying external pipe threads in this fashion for use in systems at up to 5000 psi. ▼▼▼

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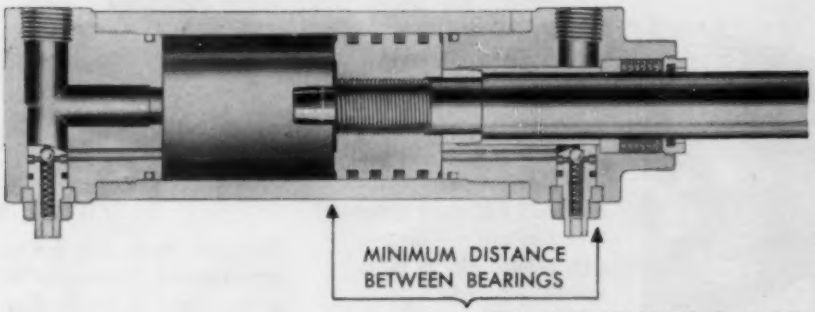
ONLY *Pathon* HYDRAULIC CYLINDERS GIVE YOU ADEQUATE SPACE BETWEEN BEARING POINTS . . .



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3. Reduced power eating friction
4. Eliminates rod cocking at end of out stroke, providing more rigid unit
5. Eliminates need for internal spacers

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Vickers maintains a Hydraulics Training School for engineering, maintenance and service personnel of both original equipment manufacturers and their customers. For further information, please contact Product Service Department directly.

7143

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

12 ADVANTAGES OF O-RINGS

1. Applicable to both static and dynamic sealing.
2. Require no adjustment.
3. Tolerance to a wide range of pressure, temperature and fluids.
4. Seals pressure in two directions.
5. Small space requirements.
6. Relatively low friction.
7. Inexpensive compared to most types of seals.
8. Easy to install, although care is required.
9. Reduces weight because of size.
10. Often allows less complicated and rigid fastening due to low clamping pressure.
11. Wide range of standard and special sizes available for almost any requirement.
12. Complete hermetic sealing is possible.

Because of their many advantages, O-rings have become one of the most important seal designs in fluid power systems. Understanding their features and sealing action may mean the difference between a leaking joint and a tight one. This article, first in a series of three, covers theory of O-ring application, and discusses advantages and limitations. Forthcoming articles will cover materials, installation design, and proper application.

HOW O-RINGS SEAL AIR & OIL COMPONENTS

• By E. J. Parker

O-RING seals, once used almost exclusively in aircraft hydraulic and pneumatic systems, are now widely used in industrial equipment. With this widening usage there are an increasing number of fluids to be sealed, broader temperature and pressure conditions, and many types of applications not described in published design information. In addition, the requirements of industrial usage are somewhat different from those of aircraft applications, on which most design information is based.

BACKGROUND

The toroidal rubber O-ring as a sealing device is relatively ancient in our industrial history. One early record of its use is shown in a United States patent of 1868, in which two rubber O-rings were used as reciprocating seals in a fire hydrant. No claim is made for the use of the O-rings as such, but only as elements of the combination, and it may be assumed that there existed some historical background at that time.

Probably due to the lack of suitable materials and the state of the rubber art, the obvious advantages of small space requirement and simplicity of the O-ring were not utilized to any great extent until the second World War. Then development of various syn-

E. J. PARKER, *Linear Incorporated, Philadelphia, Pa.*

thetic polymers, and increasing knowledge of rubber compounding, made possible mechanical rubber compounds with good oil resistance, long-lived elastomeric memory, and physical properties which made the O-ring practical for use in the aircraft hydraulic systems of that day.

Since then, rapid advances in basic polymer and compounding technology have given the O-ring an extraordinary versatility in tolerance to fluids, temperatures and pressures. The increasing familiarity and ingenuity of design engineers has resulted in an almost infinite number of applications until now over one-half billion O-rings are used yearly.

THEORY

O-ring operation is very simple, depending on only two fundamental requirements: installation between two surfaces, spaced apart at less distance than the cross-sectional diameter of the ring; and the inherent quality of the ring material, which exerts a force against the spaced surfaces in attempting to maintain the original cross-sectional dimension.

This combination of factors produces an initial, automatic seal, and addition of pressure merely increases the force acting on the separated surfaces and enhances the degree of sealing. This also holds true for other cross-sectional configurations, such as rectangular, lobed, triangular, etc. The wide acceptance of the circular cross-section is due to two secondary features.

Because of the circular section, an O-ring is able to roll slightly at a pressure or directional reversal, and this rolling action reduces starting, or "breakout" friction below that required to slide the packing. Also, stress is set up in the rubber when pressure deforms the ring toward the downstream side of the groove and into the groove corners, and this stress increasingly resists further deformation. Because of this, the O-ring has a greater inherent resistance to extrusion than most other configurations.

The extent to which the O-ring fulfills the sealing job is dependent on a balance between three factors:

a. Force exerted by the O-ring in attempting to maintain its original cross-section. With a given material, this is proportional to the amount of deformation or "squeeze".

b. Ability of the material to conform to the surfaces to be sealed. Roughly, this is inversely proportional to the hardness of the ring material, or its "durometer".

c. Characteristics of the surfaces to be sealed, or their surface "finish".

ADVANTAGES AND LIMITATIONS

The growing popularity of the O-ring seal rests on a number of desirable characteristics and advantages. However to obtain these advantages some sacrifices must be made, and of these the most important lies in the close tolerances and refined finishes required. Many of the catalog recommendations on these items can be relaxed somewhat in a large percentage of industrial applications. However, allowance must be made for closer tolerances and better finishes than would be required with some types of seals.

Certainly one of the most important features of the O-ring, from a mechanical designer's point of view, is the fact that no adjustments need to be designed into a unit, either for proper installation or field maintenance. This not only simplifies and lowers unit cost, but also protects the unit from the over-zealous use of large wrenches in the field.

The O-ring is an automatic packing. It must rely on its own elasticity in all but a few specialized applications, so it must be made of rubber or a rubberlike material, and is limited to use with fluids and temperature limits which such materials will tolerate. The fluid and temperature tolerances of O-ring compounds have been broadened greatly in the last few years, but some limitations still exist. It is necessary to use a wide range of compounds to cover all possible situations. Ease of installation is an advantage, but it should be pointed out that the best designed application can easily be ruined by sloppy assembly methods. Care must always be taken that the ring is not gouged, pinched, scratched, or installed in the groove in a twisted position, and this requirement could be a disadvantage in some cases.

If you're using O-rings as dynamic seals, use extra care to keep the installation clean. O-rings are more susceptible to contamination than lip type seals. Wiper rings are a big help in protecting rod seals.

APPLICATION

The O-ring can be recommended, within its fluid and temperature limitations, for practically all fluid power static sealing situations. Practically unlimited pressure can be successfully sealed, as long as tight metal-to-metal contact can be maintained or suitable anti-extrusion protection provided. Valuable, also, is the ability to seal not only positive pressure fluctuations, but also pressure changes from positive to negative. The gas diffusion rate is low enough to allow long-term, high-pressure gas seals, but if pressure is extremely high, and the seal sub-

jected to explosive decompression, some troubles may develop.

A word of caution should be added here about the fluoroplastics, Teflon, Kel-F, and Fluorothene as materials for O-ring seals. Because of their excellent resistance to practically all chemicals, extremely wide temperature tolerance, and low coefficient of friction, these materials are often considered by designers for difficult O-ring applications. However, it should be remembered that O-ring seals must depend on maintenance of elasticity for operation, and the cold flow characteristics of the fluoroplastics preclude long term elasticity. An exception to the general rule is the case where the O-ring is installed, pressurized, and the pressure maintained for the life of the unit. In such cases fluoroplastic O-rings can do an effective job.

DYNAMIC SEALS

As dynamic reciprocating seals O-rings are limited (within the fluid and temperature limitations of rubberlike materials) primarily by the factors of required life expectancy, surface finish, and dimensional tolerances. O-rings with suitable multi-stage extrusion protection have been successfully used at pressures of 50,000 psi and higher. Life expectancy can range all the way from many millions of cycles —as in a good many valve applications operating with low percentage cross-section squeeze and highly refined surface finishes—to one cycle applications at extremely high temperature. As a general rule, life expectancy will be increased with lower pressure, greater surface finish refinement, decrease in clearance gaps, better fluid lubricity, and lowered temperature. There is fairly good evidence that life will decrease with increased surface speed up to some critical value, depending on surface roughness, pressure and fluid lubricity. Beyond this point the O-ring will ride on a fluid film with gradually increasing life. However, this does not apply to high cycle, short stroke applications where the acceleration rate is excessive.

SURFACE

There is considerable debate as to whether surface finishes can be too refined for good operation, but in most cases this is completely academic as the attainment of finishes so refined requires rather specialized equipment. In all probability a finish of 4 to 7 micro inches RMS, with random pattern surface markings, such as would be attained by honing, represents about the ultimate in retention of fluid lubrication and freedom from sharp, wear-inducing, surface peaks .

In connection with these remarks on surface finish, it might be well to emphasize that the root mean square, or average micro-inch reading produced by an integrating type measuring instrument, represents a deviation from a datum plane, and does not necessarily describe the surface characteristics

Concluded on next page

GLOSSARY OF O-RING TERMS

ADHESION—Sticking of O-ring materials to the sealing surfaces.

AMBIENT—Defined as "completely surrounding". Hence, applied to an O-ring, the entire surrounding environment—which would include fluid, temperature, pressure, pulsation, etc.

BREATHING—The increase in bore of thin wall cylinders under pressure.

BREAKOUT FRICTION—The initial static force resisting motion between the O-ring and its mating surface.

CLEARANCE GAP—Spacing between two members being sealed into which the O-ring can be extruded.

DUROMETER—A measure of the hardness of rubber, defined as its resistance to indentation. Unless otherwise specified it is expressed in terms of Shore Durometer.

ECCENTRICITY—The relative radial displacement of two cylindrical members with respect to each other.

ELASTOMER—A material which exhibits rubberlike properties; i.e., the ability to recover its original form following large amounts of deformation.

EXTRUSION—The forcing of a portion of the O-ring into the clearance gap.

GASKET—An element used to eliminate leakage between parts in static relationship.

GLAND—The total space in which an O-ring, gasket, or seal is installed.

GROOVE—The cavity or depression machined in a unit to contain an O-ring.

GLAND WIDTH—The dimension from the bottom of the groove to the adjacent sealing surface including the clearance gap, if any.

GROOVE LENGTH—The groove dimension at right angles to the direction of squeeze.

MODULUS—The force required to stretch a material to double its original length. A measure of resistance to deformation.

NON-EXTRUSION (OR BACKUP) RING—A ring of deformable material used at one or both sides of an O-ring to prevent extrusion of the ring into a clearance gap.

O-RING—A ring of round cross-section, almost always made of an elastomeric material, which is either a seal or a gasket.

SEAL—An element used between relatively movable elements of an assembly to prevent leakage. Applied specifically to elements which are automatic in operation and require no adjustment.

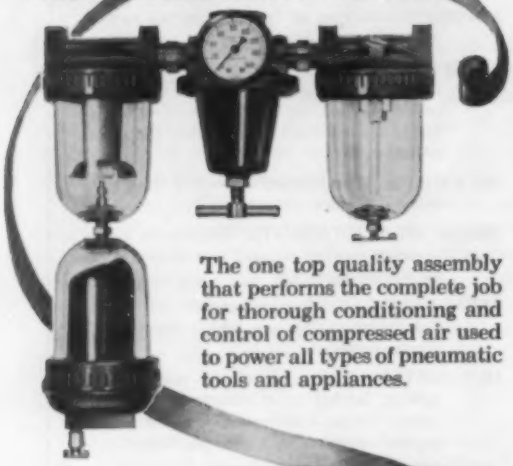
SIDELOAD—A force tending to produce eccentricity.

SQUEEZE—The amount by which the O-ring cross-section is deformed when assembled in a gland.

WIPER RING—A ring of metal, rubber, etc. with a close-containing lip facing outward to prevent contaminant from reaching a seal.

ARROW

AUTOPNEUMATIC CONTROL



The one top quality assembly that performs the complete job for thorough conditioning and control of compressed air used to power all types of pneumatic tools and appliances.

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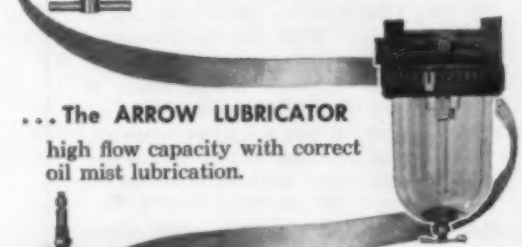

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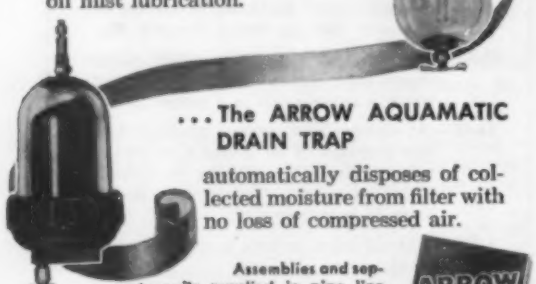
high flow capacity with correct oil mist lubrication.



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HOW O-RINGS SEAL

Concluded from page 123

which are important to O-ring use. Major differences in height, shape and frequency of surface peaks may exist in surfaces with the same RMS reading, depending on the material and the method of machining. It may be necessary in some cases to relate the RMS value to a particular material and finishing method on the basis of empirical testing. Often the use of an educated fingernail provides a more acurate gauge to the surface than can be obtained by the use of an integrating instrument.

CONTAMINATION

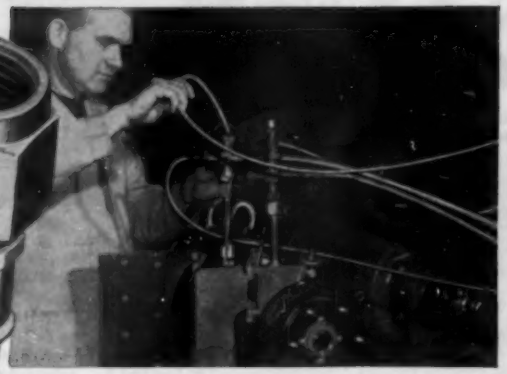
O-rings, because of the geometry of the sealing surface contact, are more susceptible to the effects of foreign-particle contamination than lip-type seals. Their use should not be contemplated as dynamic seals in cases where the system fluid cannot be kept clean. Where dynamic O-ring seals are subjected to contamination from outside the circuit, such as cylinder rod seals, suitable wiper rings should be provided to keep particle contamination from coming in contact with the O-ring. When an absolute minimum of frictional resistance is required at relatively low pressure of 250 to 300 psi, lip-type seals, such as U-cups, are preferred. When long life is the major consideration, and space or weight is not a factor, seals such as V-rings are indicated.

ROTATING SEAL

The use of the O-ring as a rotating seal presents special problems, and such use must be recommended with reservations. In the operation of a reciprocating O-ring seal, the relative motion is normal to the plane of the ring. This motion carries a film of the system fluid across the working face of the ring, and also extends the contact area. This insures lubrication to some degree, depending on the fluid, and also maintains the working face at the ambient temperature. Neither of these effects happen with a rotating O-ring. The internal elastic memory of the rubber, plus the system pressure, tend to squeeze out the lubricant at the contact faces and continuous operation against the same small area of metal induces localized heating far in excess of the ambient temperature. These two combined effects, if sufficiently severe, will result in damage to the rubber compound and possibly the shaft, and loss of sealing. Hence the O-ring as a rotary seal is limited by pressure and surface speed. No specific values can be set on these factors, but it is generally taken that 300 feet per minute rubbing speed at very low pressure is a limiting combination, graduating downward in speed, and upward in pressure to applications such as a rotating, hand-operated valve stem, which can be considered as a static seal with a moving seal squeeze. ▼▼▼

The next article in this series will be published in the June issue.

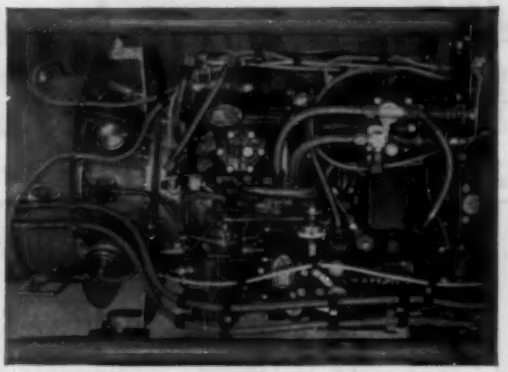
Do you have any of these flexible hose problems?



Contamination. This is a hydraulic equipment tester. Lines used previously contaminated the oil by erosion, required excessive replacement. Now fluid is always clean because chemically inert Fluoroflex-T (Teflon) hose assemblies neither corrode nor erode.

Excessive flexing. Ordinary hose on a plastic molding press, subjected to heat plus constant flexing on 50-second cycle 22½ hours a day, lasted three months. Then Fluoroflex-T (Teflon) hose assemblies were tried. Even after three years, there were no failures.

Hot solvents. Finishes using strong organic solvents are sprayed hot at 500 to 600 psi with this airless spray equipment. Ordinary hose failed frequently. Chemically inert Fluoroflex-T hose assemblies were installed. Record shows no failures after 2 years service.
(Photo courtesy Bede Products, Inc.)



High temperature. While conveying active fuels and oils, the plumbing of a jet engine is also exposed to high temperatures. Ordinary hose fails fast in this service. Fluoroflex-T hose assemblies have now had over 4 years of flight service, are specified for virtually every jet engine.

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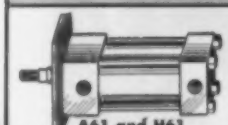
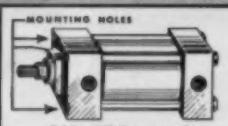


A61 and H61 Flange Mounting on Rod End (A61 not available in 8" bore)

A62 and H62 Flange Mounting on Cap End (A62 not available in 8" bore)

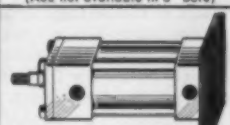


A63—8" Bore only Flange Mounting on Rod End

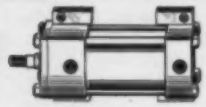
A64—8" Bore only Flange Mounting on Cap End

A50 & H50—Tie Rods not extended beyond nuts.
A51 & H51—Tie Rods extended both ends (shown).
A52 & H52—Tie Rods extended. Cap End only.
A53 & H53—Tie Rods Extended. Rod End only.
A54 & H54—Two Tie Rods extended at both ends.

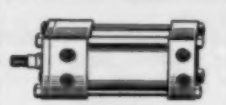
H65—Hydraulic Only Flange Mounting on Rod End



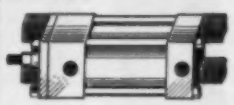
H66—Hydraulic Only Flange Mounting on Cap End



A72 and H72 Side Lug Mounting



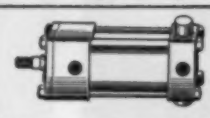
A74 and H74 Side Flush Mounting



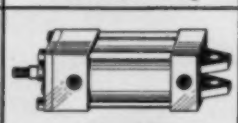
A77 and H77 Side or Foot Mounting

A81 and H81 Trunnion Mounting on Rod End

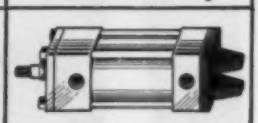
Your Choice of
CAP END CUSHIONED
ROD END CUSHIONED
or
BOTH ENDS CUSHIONED
on all cushioned strokes of all bores shown.



A82 and H82 Trunnion Mounting on Cap End



A84 and H84 Pivot Mounting



A86 and H86 Pivot Mounting

IN STOCK BORES

	BORES	ROD DIA.	ROD TURN DOWN & THREADS		"IN-STOCK" STROKES (in Inches)																				
AIR	1½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12									
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12									
	2	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	2½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	3¼	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	4	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	5	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	6	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	8	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
HYDRAULIC	1½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12									
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12									
	2	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	2½	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	3¼	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	4	1¾"	1¼-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	5	2"	1½-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36

(1) "A" and "H" Models 82, 84 and 86 with strokes over 18" require stop tubes.

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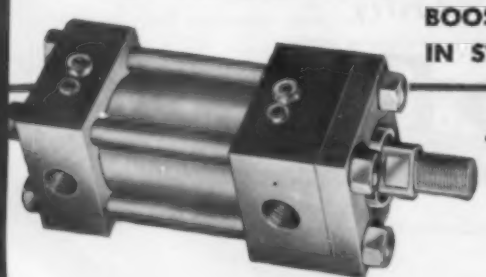
Models H82, 84 and 86 with strokes inside area (3), when operated at 1000 psi and over.

Depending upon Trunnion Pin location, "A" and "H" Models 83 with standard diameter piston rods can have longer strokes than Models 82, 84 and 86.

See Miller File #251 for oversize piston rod and stop tube requirements.



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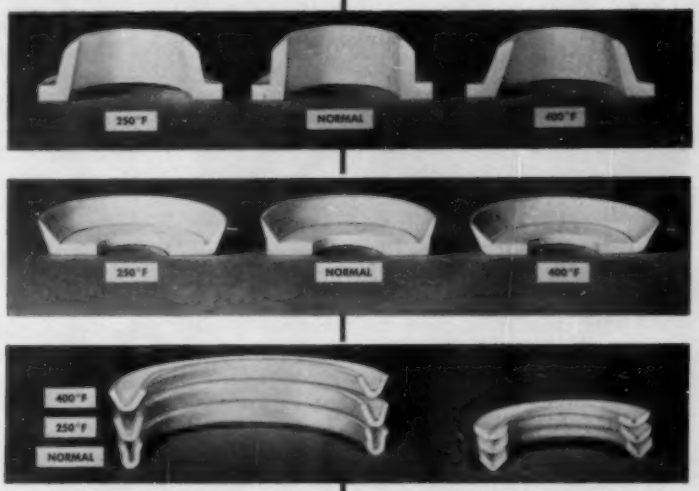
One of the newer packing materials is du Pont's Teflon, tetrafluorethylene resin. It has a low coefficient of friction and excellent properties over a wide range of temperatures. However, Teflon's thermal expansion and shrinkage, where temperature variations are 100 degrees F or more can cause leakage. This article tells how this cause of leakage is controlled by a production technique.



THESE TEFLON PACKINGS have been produced by a method which takes advantage of plastic memory to maintain sealing under varying temperatures. Photos show sealing lip diameters after cooling to room temperature from the temperatures shown.

HOW TEFLON PACKINGS BEHAVE ... *where temperatures vary*

• By Howard Asp

WHEN first placed on the commercial market in 1946, attempts to use Teflon as a packing involved mere shape and size duplication of conventional materials. The Teflon parts were molded from powder or machined. For many applications this was and still is satisfactory, but where temperature variations were involved, even as low as 100 degrees F. it was soon learned that Teflon's thermal expansion and shrinkage could allow leakage.

• **Pressure Actuated Packing Behavior**—Unconfined Teflon packings, such as flange packings, or rod seals, piston cups and U-cups used in hydraulic applications, undergo a leak-creating behavior, if such packings are machined or are conventionally molded. The leak causing action results from linear thermal variations in the sealing lip circumference.

Since such packings are used singly, they must depend on a secure lip contact to maintain a seal. Rubber packings, because of their elasticity and the fact that their shape is easily influenced by hydraulic pressures, are able to maintain a secure lip-edge seal within the limits of their temperature and fluid resistance. Teflon, however, is a relatively inelastic and considerably stiffer material, thus its behavior under hydraulic forces is far from comparable to rubber in similar shape and section. Sealing lip diameters, in this class of packings, are necessarily preloaded or pre-stressed to the member against which they are to seal, i.e., I.D.'s are made smaller than the rods and O.D.'s are made larger

HOWARD ASP, *President, Halogen Insulator & Seal Corp., Franklin Park, Ill.*

than the cylinder bores. For example, a flange packing or rod seal for a 2.000-inch dia. rod may have a lip diameter of 1.990 or 0.010 inch prestress. At constant temperature, normal Teflon will elastically recover only approximately one-third of its deformation, hence, in such a rod seal machined of Teflon, a .010 inch prestress in the free state is equivalent to only .003 inch residual effective pre-

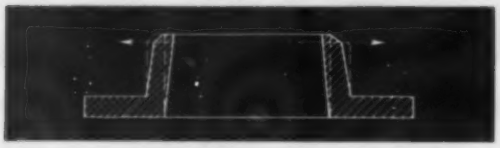


FIG. 1. MACHINED ROD SEAL has this lip action with increasing temperature.

stress after installation. Since the linear coefficient of expansion is .001 inch per inch per 18 degrees F, a temperature rise of only 27 degrees F is sufficient to nullify this residual prestress.

Figure 1 shows the lip action during temperature increase of a machined Teflon rod seal. Any further temperature rise will elongate the lip circumference according to the expansion coefficient with the result that the lip will become free of the rod at a relatively low temperature. Hydraulic forces may or may not push the lip back in contact with the rod depending on the magnitude of the hydraulic pressure in relation to the actual flexibility of the Teflon lip section. This type of packing is generally used in hydraulic cylinders in which the pressure on the return stroke is reduced to backpressure only. During this low pressure period the lip can free itself of the rod, and thus it may be free of the rod when the hydraulic surge is introduced on reversal of stroke, allowing high pressure leakage at the start of the stroke, and then allowing low pressure leakage during the return stroke.

Piston cups of Teflon, like rubber, leather or composition cups, must have a lip diameter greater than the cylinder bore to achieve a seal. When heated to service temperature the Teflon lip elongates circumferentially, but is prevented from actually increasing in diameter by the cylinder wall. If such a cup is machined, the lip section behaves like a thin ring and the attempted circumferential expansion is converted to radial expansion of the lip section with the O.D. remaining constant. The effect of this action is the same as a resizing or reforming operation since it is conducted under heat and pressure. The inelasticity of machined Teflon prevents this operation from being completely reversible when the temperature decreases, and the result is a reduction of lip prestress at very moderate temperatures and a complete freeing of the lip after exposure to high temperatures.

U-cups of Teflon must have both lips prestressed to achieve a seal. Since this shape is basically a combination rod seal and piston cup having a common base, both lips will behave independent of each other in the manner described above, on parts that are machined or conventionally molded. The inner lip follows the behavior of a rod seal lip, and the outer lip follows the behavior of a piston cup lip, in the directions shown in Figure 2.

• **Static Joint Loss**—In addition to maintaining a dynamic seal at the lip, Teflon flange packings and piston cups must maintain a tight static joint over varying temperatures where the base of the seal is clamped. Here again, with machined parts, an attempted base thickness increase as the result of expansion at increased temperatures is prevented by the clamping metal parts which are locked in position. Thus the resulting volume increase must flow radially while the base thickness remains constant. This constitutes a resizing operation conducted under heat and pressure. During the succeeding cooling cycle, the radially expanded material will not creep completely back into the clamped area, and the initial clamping squeeze is lost. This provides a second avenue of leakage on machined Teflon parts and this can only be compensated by mechanical take-up on the clamping assembly after each heat cycle. This is an inconvenience on ex-

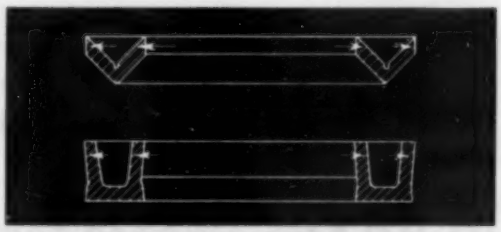


FIG. 2. MACHINED OR MOLDED V-rings and U-cups have this lip action with increasing temperature.

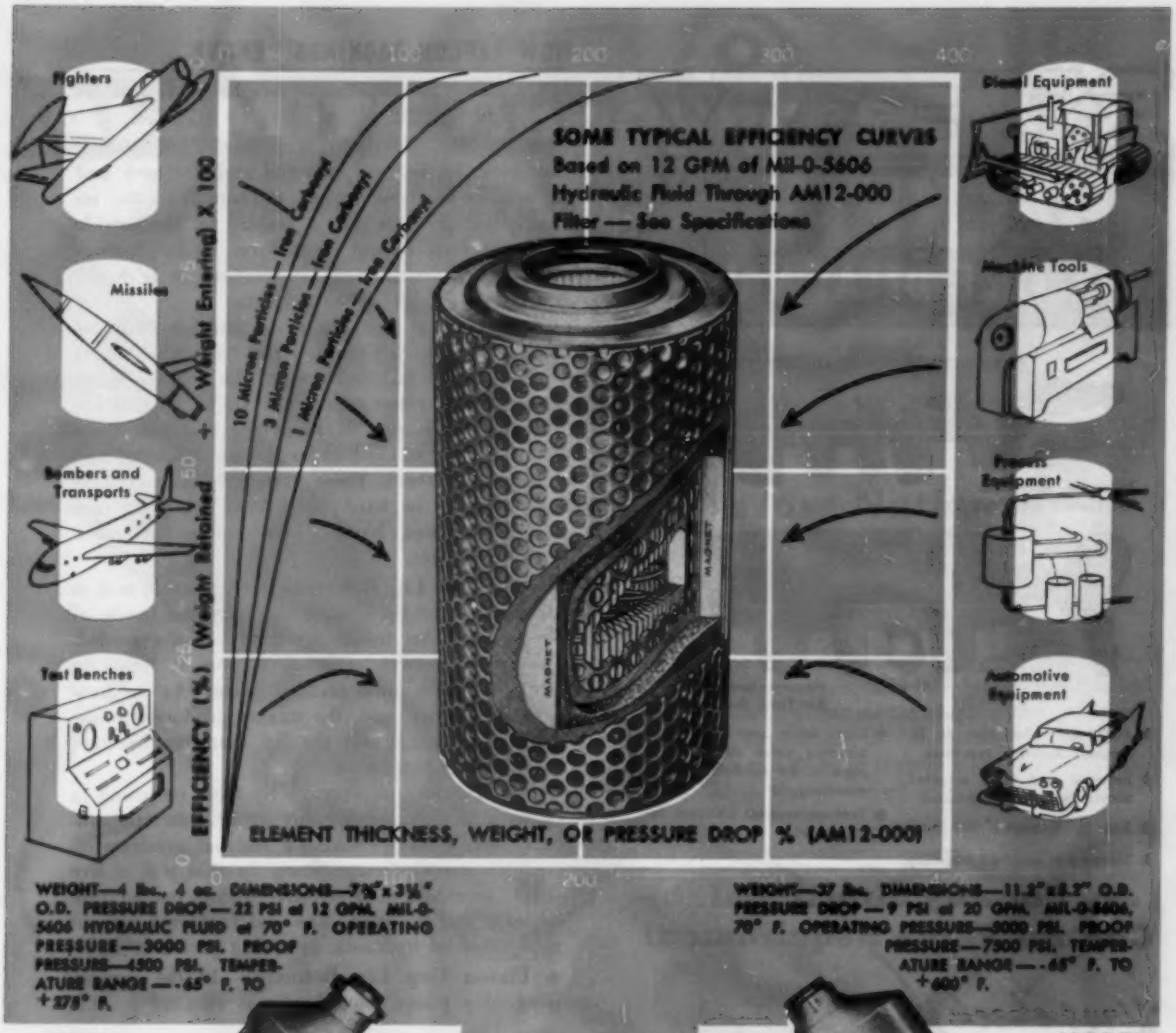
ternal rod seals and an impossibility on piston cups or internal seals.

• **Plastic Memory**—Like other plastic materials, Teflon has a plastic memory. The amount of memory recovery is proportional to temperature and is complete—100 percent—at 620 degrees F. This is the transition point between the crystalline and amorphous states of the material.

A solution to the leakage problem experienced with machined or molded parts is to make Teflon packings to a shape and size from which plastic memory, with increased temperature, will flow the sealing lips in the proper direction to maintain sealability. Engineering refinements and production methods developed over the last four years have perfected "memorized" packings.

Basically, the memorizing operation consists of forming the parts in precision molds under heat

Continued on page 130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HOW TEFLON PACKINGS BEHAVE

Continued from page 128

and pressure. The preform is cured, unoriented, flat stock. In the case of a rod seal, the neck and lip section are bent up into position from the inside of the preform. For a piston cup, the outside of the preform is bent up to form the lip. V-rings and U-cups are formed by bending up both the inside and outside of the preform.

After removal from the mold, and for 24 hours thereafter, there is an initial kick-back which must be anticipated in mold design, but further aging for as long as two years has shown no further dimensional changes at room temperatures. Parts may be safely stocked under the conditions of any normal store-room. These parts are as smooth as the polish of the hard-plated mold finish and are unusually dense, having been compacted under severe pressures.

• **Rod Seal Lip Behavior**—When a rod seal is memorized, the lip is stretched from the inside of the preform, but the elastic limit is not exceeded. The lip, however, "remembers" that it wants to return to its original small diameter. As the temperature is increased, the strains produced in the seal are relieved and the lip diameter becomes progressively smaller.

Since the rod prevents the lip from returning to its natural diameter for any given peak temperature, there always remains a residual prestress on cooling to room temperature. In this way a live seal is created that is effective during temperature increase and decrease. The seal functions without application of hydraulic or spring pressure.

• **Piston Cup Lip Behavior**—In the memorizing of a piston cup, the lip is bent up from a

FIG. 3. PISTON CUP fabricated with plastic memory has this lip action with increasing temperature.

larger outside diameter. Thus, the lip circumference is forcefully reduced, imprisoning compressive strain. Further, the stock is bent approximately 80° and shear strain is imprisoned in the cup heel. Here, the lip "remembers" that it wants to be larger in diameter and the heel "remembers" that it wants to lay out flat, as shown in Figure 3. Application of temperature releases both strains progressively, and thus the lip is held in sealing position contact with the cylinder wall under all conditions of temperature rise or fall and, again, without application of hydraulic pressure.

• **V-ring and U-cup Lip Behavior**—Parts of this general shape are made from preforms that are both smaller on the inside and larger on the

Concluded on page 132

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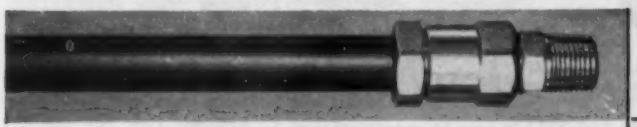

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HOW TEFLON PACKINGS BEHAVE

Concluded from page 130

outside than the finished part. As stated earlier, these shapes are merely a combination of a rod seal and piston cup, having a common base. Consequently, the lip behavior is independent, the inner lip behaving like a rod seal lip and the outer lip behaving like a piston cup lip. The action is shown in Figure 4.

In the case of a V-ring, however, the shear strain at the heel is only 45° and thus the release of this

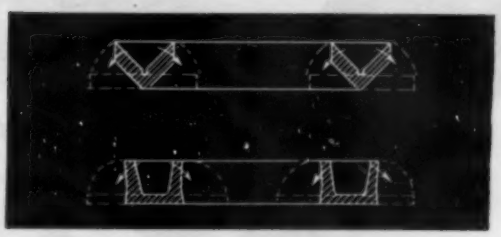

FIG. 4. V-RING AND U-CUP fabricated with plastic memory have this lip action with increasing temperature.

strain, with temperature increase, is of proportionally smaller magnitude than the rod seal, piston cup, or U-cup in which the heel is formed at 80° to 90°.

• **Base Thickness Behavior**—One of the most important features of these Teflon rod seals or piston cups is the ability of the packing to maintain a prestressed static sealing condition in the clamped area. In making such parts, the base preform thickness is substantially reduced under severe compacting pressure. After the initial rebound during the 24-hour seasoning period, compression strain still exists in the base section. As this strain is released by application of heat, the clamped section wants to increase in thickness, but cannot do so since it is mechanically confined. Hence, an axial loading against the confining plates always exists. This serves to maintain a tight static seal. Base thickness growths of .005 inch to .008 inch on a basic .125 inch dimension have been observed.

• **Stiffness, Temperature and Memory**—The progressive reduction in the stiffness of Teflon with increasing temperature is particularly helpful in the maintenance of low friction since this characteristic acts in a direction opposite to the contact pressure created by the disorientation of the sealing lip. Even at the highest temperatures, where the lip wants to return almost to original size, the softer more flexible state of the material sufficiently offsets the forces of memory to allow secure lip contact without an increase in friction. ▼▼▼

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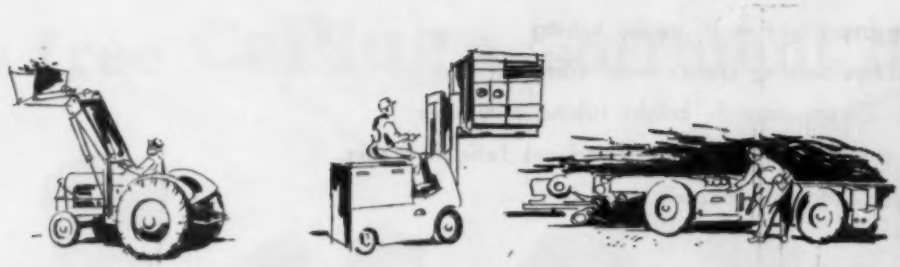

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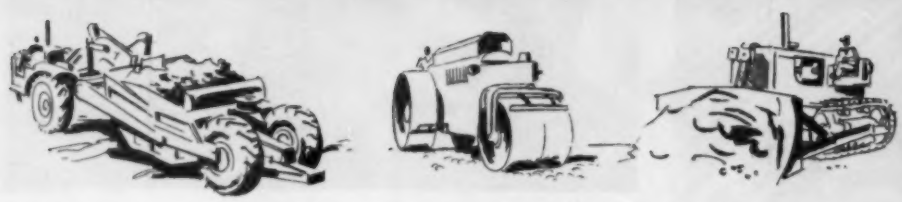

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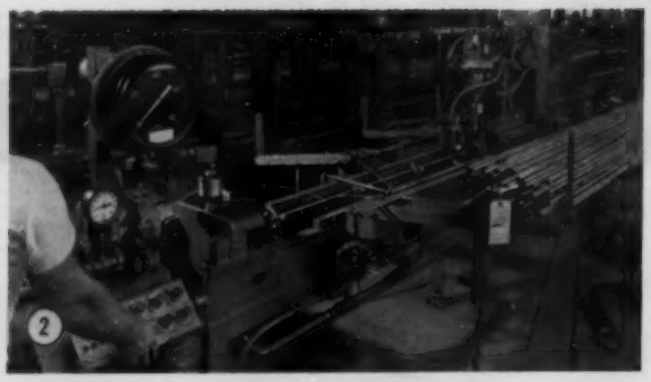

FIG. 2. HYDROSTATIC TESTING of each length of tubing is a manufacturing requirement. A special clamping design on this equipment makes 100% testing economically.

FIG. 3. FLARE TESTING is performed on the basis of 35% maximum increase in OD. Tubing must flare without developing minute surface breaks or notches.

• By Louis F. Calzi

A LEAK-PROOF tubing system begins with the selection of the material for the hydraulic line and continues through production of the tubing and its installation in the system. Steel tubing which is now much preferred for hydraulic lines has many advantages over pipe in preventing leakage. Tubing is easily bent so that pipe fittings which are subject to leakage

Louis F. Calzi, *Engineer, Superior Tube Co., Norristown, Pa.*

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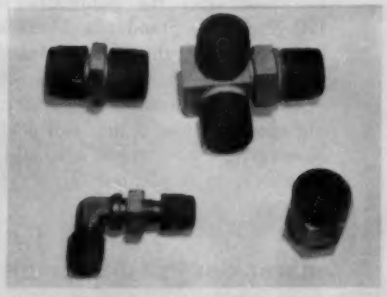

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what to check when

SPECIFYING HYDRAULIC TUBING

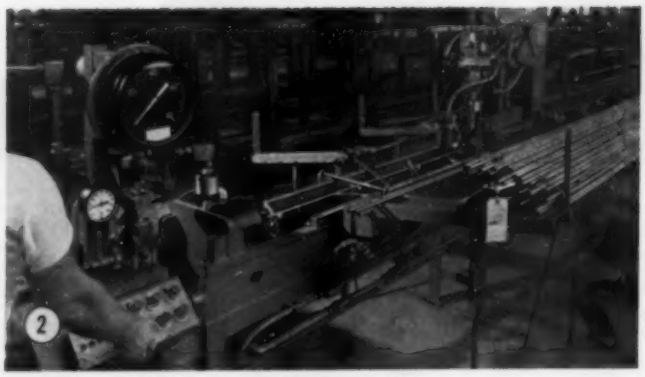

FIG. 1. CHECKING INSIDE of raw stock for hydraulic tubing is one of the first steps in manufacture.

FIG. 2. HYDROSTATIC TESTING of each length of tubing is a manufacturing requirement. A special clamping design on this equipment makes 100% testing economically.

FIG. 3. FLARE TESTING is performed on the basis of 35% maximum increase in OD. Tubing must flare without developing minute surface breaks or notches.

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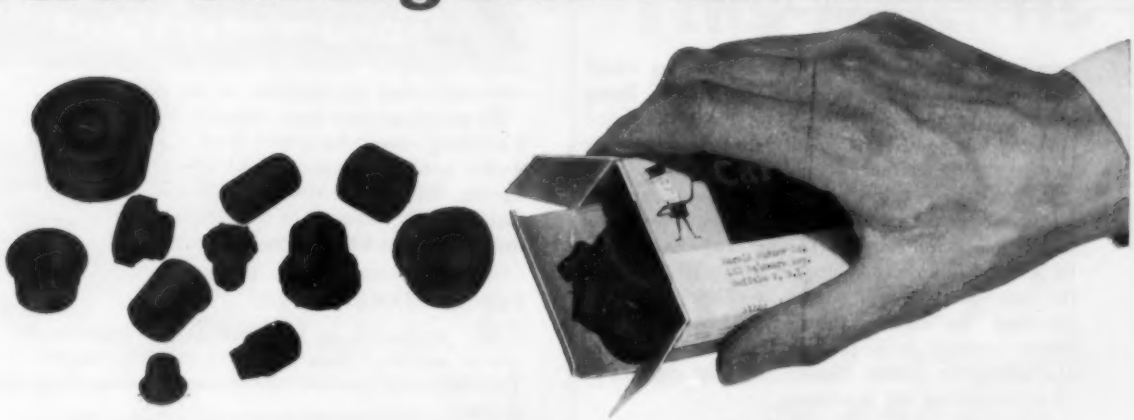

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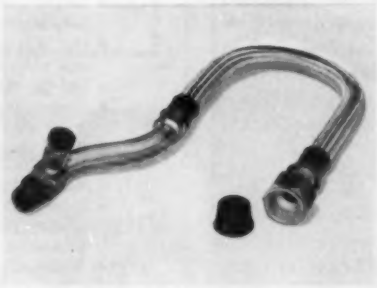

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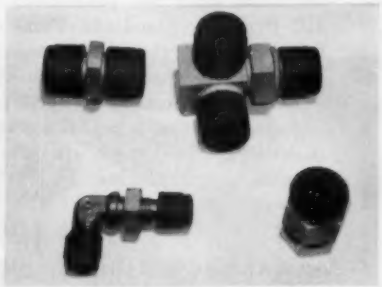

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are eliminated. Tubing eliminates threading which removes a part of the pipe and weakens it. Being less rigid than pipe, tubing absorbs vibration and has less tendency to transmit vibration from one connection to another.

The fact that tubing bends easily and requires fewer fittings cuts installation time and costs and simplifies maintenance. Tubing reduces weight by giving the required strength with minimum wall thickness and by reducing the number of fittings required. Its smooth interior and sweep bends lessen pressure drop. Its cleanliness bars dirt and scale from the system. Finally, the neat appearance of tubing helps sell machines.

TUBING MATERIAL

Low carbon steel tubing is preferred for most hydraulic systems. The principal exceptions are aircraft systems where stainless tubing is usually specified. The use of low carbon steel tubing has increased since the publication of the SAE and JIC Hydraulic Standards. These standards presently recommend the use of seamless, low carbon tubing for pressures from 0 to 3000 psi.

Even though tubing meets all of the manufacturing specifications, it may not perform satisfactorily in service. Some steels are subject to aging and precipitation hardening. These changes in properties take place at atmospheric or moderately elevated temperatures after the metal is cooled or cold worked. They occur at a slower rate even where tubing is stored at room temperature and adversely affect the ductility of the metal.

To guard against these changes, hydraulic quality tubing should be drawn from a carefully controlled non-aging type of steel which will not age harden. Whether in storage or in use, this tubing maintains the same yield strength, elongation, and ductility it had when shipped from the mill.

Table 1

MINIMUM BEND RADII FOR HYDRAULIC TUBING

Tube Diameter-in.	Minimum Bend Radius-in.
1/16	3/16
1/4	9/16
5/16	11/16
3/8	13/16
7/16	1 1/4
1/2	1 1/4
5/8	1 1/2
3/4	1 3/4
7/8	2
1	3
1 1/8	3 1/2
1 1/4	3 3/4

TUBING MANUFACTURE

The production of hydraulic tubing requires a special series of tests and processing techniques. The following procedures illustrate the care exercised:

- Select raw stock from non-aging steel with .12% maximum carbon content for maximum ductility.
- Sample inspect raw material to spot any defects in the inner diameter.
- Mandrel draw tubing for smooth ID close to finish size. Tubing is given a plug or sink draw to finish size.
- Bright anneal to prevent carbon pick-up and to help maintain ductility.
- Hot solvent degrease before all process anneals and shipment to assure cleanliness.
- Deburr tubing ends inside and outside.
- Hydrostatic test each length of tubing at maximum working pressure.
- Flare inspect on a basis of 35% minimum increase in OD. Tubing must flare without developing minute surface breaks or notches.
- Coat with a special high quality, wax-type, inhibited rust preventive. This gives much longer protection than ordinary slushing oil.
- Wrap in waterproof paper and box for shipment.

BENDING

Correct bending of the tubing to the desired configuration is as important as correct material and manufacturing specifications. Five basic methods for bending round tubing are:

1. Press bending
2. Roll bending
3. Stationary die form bending
4. Revolving die bending
5. Bending with a filler

Wrinkling, stretching, and flattening tendencies limit the bending of any tubing material. Generally

Concluded on page 138

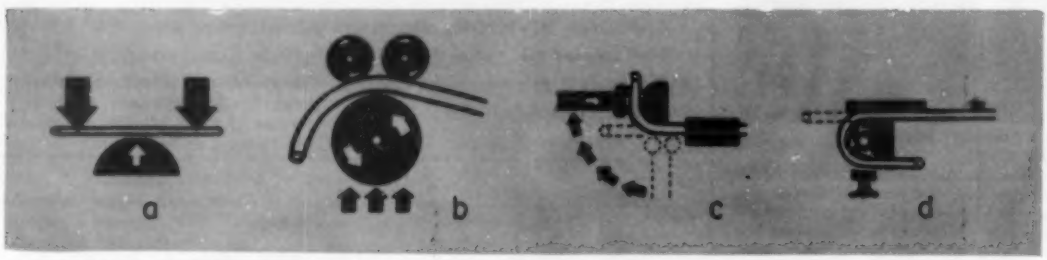

FIG. 4. TUBE BENDING METHODS. (a) Press bending. (b) Roll bending. (c) Stationary die bending. (d) Revolving die bending.

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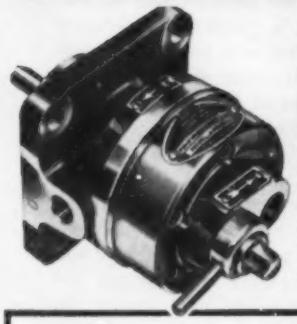

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- No idle pockets or passages to cause air locks or allow coagulation
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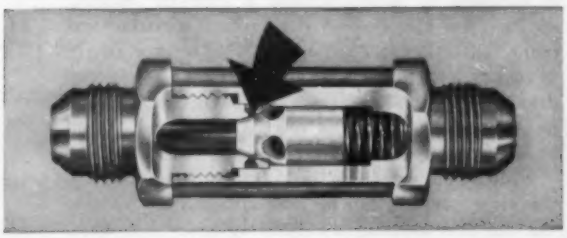

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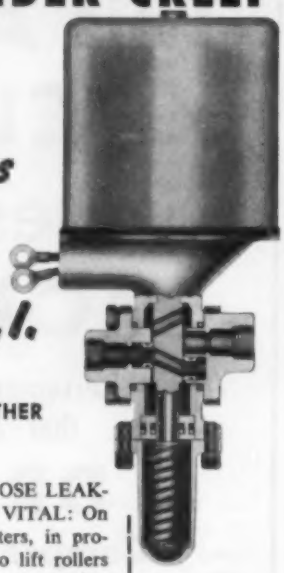

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is assured through the lapping action of the Shear-Seals against the slide, which actually improves the sealing qualities of the valve with each operation. The small amount lapped from the Shear-Seals after millions of cycles is compensated by a back-up spring. Dirt or pipe scale cause no damage or failure because the spring keeps the sealing surfaces in constant intimate contact.

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SPECIFYING HYDRAULIC TUBING

Concluded from page 136

the minimum bend radius of a tube depends on the bending method and the ratio of OD to wall thickness. Press bending is particularly adapted to bending heavy wall tubing to a minimum radius of six times the outside diameter of the tube and within included bend angles of 120 degrees or less. With wing dies, this method of bending can produce a minimum radius of three times the OD.

Roll bending is also adapted to heavy wall tubing, but as with press bending the minimum radius of bend is approximately six times the diameter of the tube. In roll bending using three, grooved, power driven rolls, the tube is continuously fed through the machine to produce complete circles

How to Select Fluid Line Sizes

The usual method of sizing fluid lines is based on the rule-of-thumb that velocity should not exceed 15 fps. However this can lead to poor design, and a safer procedure is based on Reynolds Number to insure laminar flow and minimize heating. This method is discussed in the article "How to Select Fluid Line Sizes" which appeared in the August 1955 issue of AH. Reprints of this article are available.

or helical coils. The straight, unbent ends have to be cut off, although there are a few 4-roll bending machines which will bend true arcs to the very end of the tube.

For small tubing to ⅝-inch OD the stationary die method is one of the most common. The tube is wrapped or wiped around a grooved bending die to form the desired shape. Both circular and non-circular bends are possible and several curves in two or more planes can be produced with special dies. This method is very versatile because it may be applied where only a few parts are to be bent or where thousands of similar pieces must be made.

Instead of wrapping the tubing around the die, the same purpose can be accomplished by rotating the die and keeping the bending shoe stationary. This revolving-die method is particularly advantageous for the bending of thin wall tubing to small radii, since the tubing can be entirely confined externally and internally at the point of bend.

Wherever metal is formed by rubbing over a tool, lubrication is very important. Light mineral lubricating oil is recommended for the bending of carbon steel hydraulic tubing.

One of the principal precautions is not to bend the tubing to a smaller radii than indicated for the tube diameter. Minimum bend radii for various tube diameters are listed in Table 1. Thin wall tubes should not be bent without a mandrel. Carrying a mandrel too far forward can cause breakage. Carrying it too far back can cause flattening. Tubes should be clamped firmly to prevent slippage which can kink or flatten the bend. ▼▼▼

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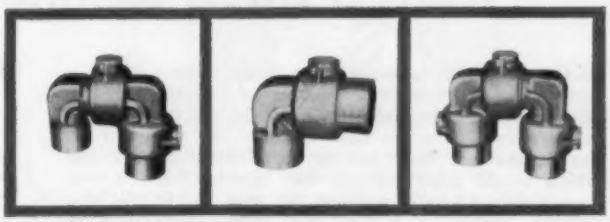

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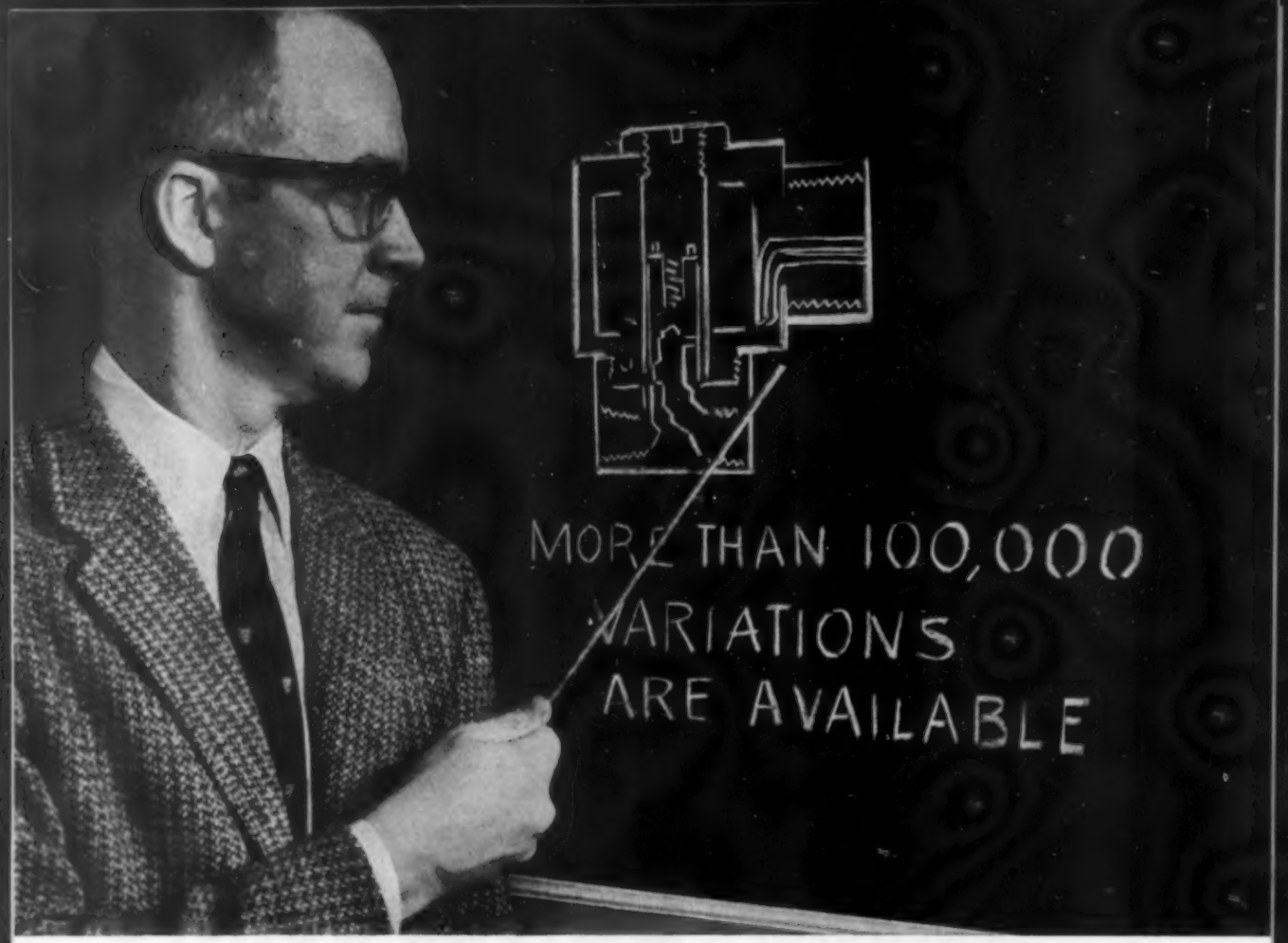

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DESIGNING A SEAL

...for very high pressure

To seal 45,000 psi, it pays to take a good, hard look at every detail of design and construction. Start with the basic principles of seals, and carefully weigh each point on the way. Here's a step-by-step description of how such a problem was solved, with an insight into some of the reasons why packings work . . . or fail.

• By Jan M. Garvin

APPLICATIONS involving higher pressures arise quite often on industrial hydraulic design boards. We first tried our hand at high pressure packing on an intensifier for testing forged steel cylinders. The intensifier plunger has a dynamic seal and the intensifier is capped at both ends and sealed by a static seal.

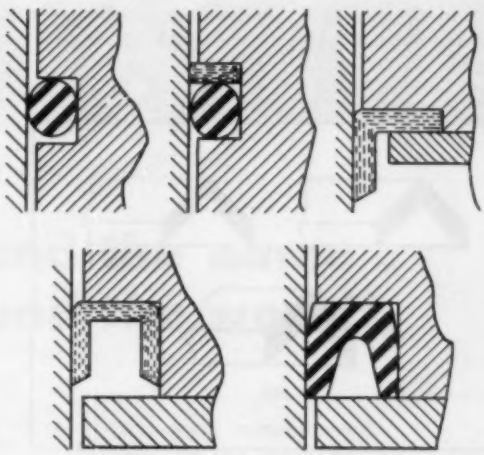
• **Past experience**—Pressures up to 5000 psi, with water or oil as the hydraulic medium, are now so common in the fluid power industry, that the equipment designer has available data and information on a variety of packing types which will do the job efficiently. The only problem is choice of a product tailored to the individual application. Also, the method of housing the packings has been explored sufficiently, and standardized for many packing types, such as O-rings, U-cups, etc.

Two particular fields have numerous high pressure applications: production testing of piping at a pressure of 15,000 psi and shells where 25,000 psi is not uncommon. This knowledge and experience in selection of packing type and suitable housing method becomes an important part of the fluid power engineer's know-how. It is essential that this information be readily available to the hy-

JAN M. GARVIN, *Vice President, Machinery & Machine Supplies Company, Inc., New York City.*

Packing data courtesy of The James Walker Packing Company, Inc., Chicago, Ill.

Why Packings Fail At High Pressures



• O-RINGS used alone extrude through the clearance which tends to increase with pressure.

• BACK-UP RINGS are effective in preventing extrusion in many applications. At very high pressures, however their value is limited.

• CUP PACKINGS have a heel which must be compressed to seal. Obtaining just the right amount of compression is uncertain at very high pressures.

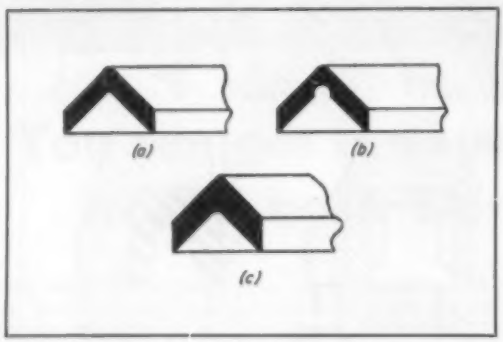
• U-PACKINGS have wear concentrated at the corner which rests against clearance. Material is extruded at the point of eventual failure.

draulic equipment designer from other than just hear-say sources.

• **Dynamic seals**—Of particular interest are dynamic seals, such as ram and piston packings, and those static seals which do not fall into the flange seals group. Flange seals do not present too many problems, as it is usually possible to use a solid metal gasket, such as annealed copper, properly confined and compressed to provide a satisfactory seal.

Therefore, let us examine dynamic seals of the reciprocating type, where we can provide satisfactory answers, and invite those with corresponding experience in the rotary seal field to come forward and tell us about it. The satisfactory solution of the dynamic seal problem will also take care of the static seals other than flange seals, such as pipe expansion joints, cylinder heads, etc.

• **Elimination**—Compression type packing is out, having been abandoned already at lower pressures than those with which we are concerned. There remains the group of seals of the automatic type, which assure contact with the surface to be sealed in proportion to the pressure applied: O-rings and related types, cups, U-packings and V-packings.



V-RING DESIGNS show compromise between flexibility and sufficient material at lip where wear occurs. Grooved design in (b) achieves both, but gives no support above apex of V-ring. Because flexibility is not a problem at very high pressures, groove was eliminated and depth increased (c).

Let us try to eliminate further. O-rings and related types are prone to extrusion through the clearance which tends to increase when pressure is applied. Devices such as back-up washers act only as retardants of extrusion failures. They are quite efficient as far as life factor is concerned in normal applications, but with high pressures, and therefore accelerated extrusion attrition, their retardant value is not good enough.

Cup packings seal the moving surface by means of a lip—an automatic seal—but their heel has to be compressed to seal. Controlled compression would not be sufficient, and hard compression would cause it to flow. Too much risk is involved to move with it into the "rarified regions" of very high pressures.

U-packings are automatic. When properly housed and made strong enough not to break at the lip base under pressure impact, they will seal high pressures. But for how long? The wear of the U-packing is concentrated at the heel corner, which rests against the clearance between the stationary and the moving member. This is where extrusion occurs and packing material is frittered away. Thus material is removed at the point where the failure break eventually occurs. Under our critical conditions, this is not a healthy situation.

• **Design**—About all we have left are V-packings. The seal is automatic. The individual sealing rings nest in each other at 45° to the axis of movement, so the wear is at the lip only. As wear progresses, the lips are pushed outward, continuing to seal, so the life is built into the design. The nest of rings promises more than one lip contact, thus more life and seal efficiency insurance.

There are some weak points in the conventional V-ring design. To provide more body at the lip, where wear occurs, but sufficient flexibility at the hinge of the "V" to insure ready flexing under pressure changes, most strong, fabric-and-rubber composition V-packings have an internal groove under the hinge. Those which have no groove must sacrifice lip body, and are uniformly thinner—not too much wear resistance in those.

This groove is said to have certain advantages. Being filled with the fluid, it provides lubrication. Abrasives in the fluid find their way here and remain out of harm's way. The fluid in the groove, when under pressure, helps to spread the lips further. But the fact remains that above each V-ring hinge—its weakest point—there is lack of support, and if we are going to seal 45,000 psi, is this sound?

Even in normal applications where shocks can send the pressure surging to regions with which we are concerned, experience has shown that this hinge has to be either fully supported or reinforced. Conversely, will the lack of the more flexible hinge be a drawback in our job? We make a calculated guess that at 45,000 psi the packing will have no trouble flexing. So, we eliminate the groove. We now have a solid nest of V-rings, not too thin (lip wear) and not too thick (flexing).

How are we going to abut our V-rings? This is where the whole brunt of the sealed pressure will be exerted, and where there is dangerous clearance through which we do not want our precious V-rings to go squirting like toothpaste. How about a metal female ring? It certainly looks good, but let us take another look. It will have to have a clearance

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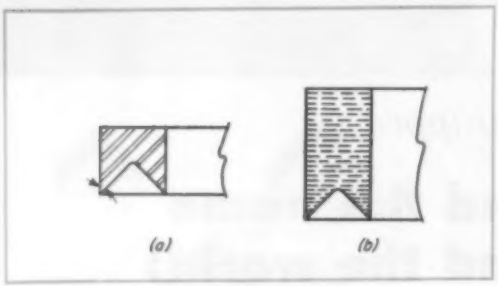
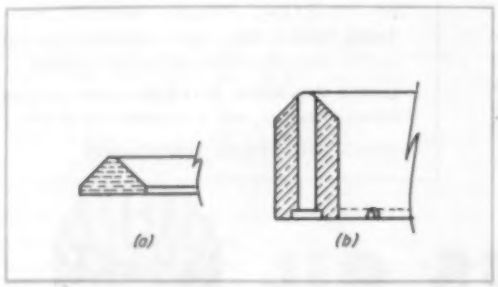
at sliding contact, so we just transfer our problem to the top V-ring, and we have done nothing to it to prevent or retard the "toothpaste" effect. Or, maybe there will not be any clearance. We look with mistrust at the thin metal edge. Will the pressure tend to deform it beyond the metal's elastic limit? We recall a case, where with an alloy steel female ring at 25,000 psi, there was no clearance between the ram and the ring after a few strokes—and no ram return either. No, the metal female ring is out.

What then? We shall have that dreaded clearance after a time, even if we start with a lapped fit. And a look at the relative cost chart of metal finishes and tolerances tells us that we shall not start with it. We must have a ring made of resilient material, which under pressure will expand radially, so that clearances are closed to the underlying V-rings. But, when pressure is removed, we want this ring to decompress to original size so that it does not seize the moving surface permanently. We also want strength, toughness and body, so that our V-rings are well abutted and working at maximum efficiency. We also must realize that if there are clearances, there will be extrusion, and if it progresses beyond a certain point, we shall have failure. We want to retard this as much as possible.



METAL FEMALE ADAPTER (a) must have clearance at sliding contact with possibilities of extrusion at this point. High pressure may permanently deform it. Final design (b) is specially molded fabric and rubber. Depth is twice width.



MALE ADAPTER provides passage for pressure surges to the bottom V-ring. Adapter need not be flexible or have close fit on O. D. or I. D.

• **Solution**—Going by previous experience with lower pressures to 5000 psi, we conceived a specially woven, fabric-and-rubber, molded construction, with the fabric plies perpendicular to the axis of the moving member—"ply-to-rod" construction. With high content of strong, specially-woven, multi-layered fabric, the fabric-and-rubber composition, molded under extremely high pressure conditions to insure intimate penetration and bond between rubber and fabric, provides a material of high strength, but adequate resiliency. It has shown its ability to withstand the frittering extrusion wear in the ID corner, where the clearance is most dangerous. Normally we would use it to a depth equal to the packing's radial section, but here we increase it by 100%.

To complete our packing set, we must provide a suitable support for the bottom V-ring at the other end of the stack—the male adapter ring. When V-packings were first introduced, the name was appropriate, because it had to "adapt" the conventional square bottom face of the stuffing box to receive the V-rings and support the delicate sealing lips of the bottom V-ring against damage when the packing settles on the return stroke. It was, and in many cases still is, a portion of the packing not contributing to the sealing function of the packing set.

A designer's aim is always to justify even the smallest part that must be included in the assembly. Besides "adapting", can this ring be made to perform a positive function in sealing the pressure, and thus be better justified? The bottom V-ring is the first to be exposed to the pressure surge in the fluid. If the lips expand instantaneously and seal, the function of the packing is achieved. If we provide a free passage for the pressure surge in the fluid to the space between the sealing lips of this ring, we shall have quicker sealing response. Pressure porting of the male header ring is the answer. On the other hand, this part does not have to be flexible and resilient, and there is no need for it to fit closely on OD or ID. Therefore, we can relieve it there, eliminating wear where it does not help us, and make it of rigid material, moldable or machinable, to provide pressure porting. For our high-pressure application, where weird things are likely to happen to rigid, unsupported and non-confined parts, we make it of high-tensile bronze.

A few more details and our packing set will be complete. We check our empirical charts for suitable number of V-rings, which should be contained in this set.

Our next question is whether split or endless rings should be used. To provide maximum, built-in efficiency, even at the expense of installation convenience, we specify endless rings.

• **Stuffing box**—We are extra careful in our stuffing box design. The ram is well finished (ground and polished, 15 micro-inches minimum),

well-guided to avoid side loads on packing, the gland bushing clearance as small as we can afford. Clearance is .0005 to .001 inch, if we can get it and not more than .002 inch. The take-up gland is adjustable, not for compressing the packing which is useless and detrimental with V-packings of this type, but to allow for accurate adjustment at installation. The studs are strong enough to take the load, with liberal safety margin to allow for fatigue stresses. Shims are provided to insure even and accurate packing adjustment between the gland and the face of the stuffing box. A 15% chamfer at the mouth of the stuffing box bore prevents lip damage at installation.

When the parts are made, they are assembled carefully. The packing is adjusted so that it is snug in the box, but not floating and not tight. The static seal boxes are not as ideal as we wanted them—the clearance is .003 inch. The device is piped up and connected to the pressure source.

• **Test**—The pressure is applied. From the shelter of a concrete column we watch the pressure gauge creep up to 45,000 psi. Test schedule says five minutes. The gauge stays there. No leakage and no pressure drop. The packing is good.

The device is decompressed, disassembled, and we examine the end cap packings. These are in perfect condition with no sign of wear or incipient failure. ▼▼▼

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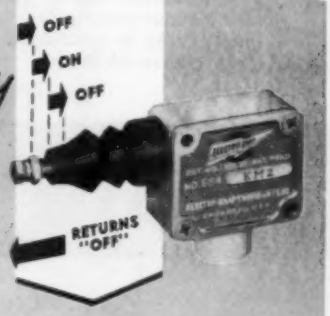
Keep It Simple

with the ELECTRO-SNAP *One-Way Impulse* PRECISION LIMIT SWITCH



Type ES4-KM2 shown

Before finalizing design on your automatic tools or systems, get full details on the ELECTRO-SNAP ES4 family of switches. Many variations available . . . all trouble-savers!

- Fewer switches needed.
- Simpler, cheaper than timers.
- More reliable than fancy circuitry capable of same job.

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ELECTRO SNAP

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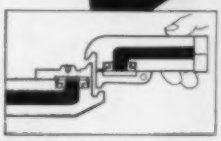
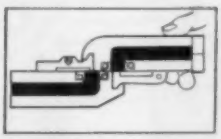
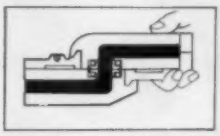
with NEW LAPPED STEEL SEALS



HOOK UP

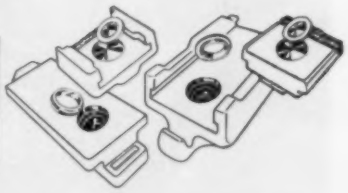


PUSH-CLICK!



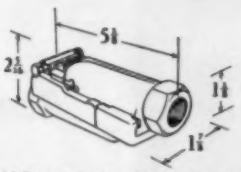
FREE FLOW

The Model H-730 Coupler now has identical HARDENED steel seals in each half. These interchangeable lapped steel seals are highly resistant to abrasion and nicking. Their durable quality assures a tighter, more positive, leak-proof, free-sliding seal . . . long-lasting, trouble-free.



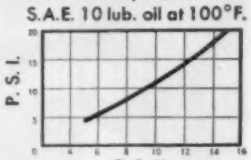
Designed and engineered as a quick-connect, self-sealing breakaway coupler for ALL fluid carrying hoses. Intended for service up to 2000 P.S.I.—will withstand surge pressure above 5000 P.S.I.

Unusual features are the high flow rating and relatively little pressure loss (see chart). Anodized aluminum die castings make this unit strong, corrosion resistant, light weight and dependable.



½" N.P.T. Female Both Ends

Pressure Drop vs. Oil Flow
S.A.E. 10 lub. oil at 100°F.



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Titeflex Couplings are *leakproof* at *all* operating pressures—the higher the pressure the tighter the seal! Couple or uncouple in ONE second... without the aid of tools. Straight-through or single or double check-valve types. Allow free flow of *any* viscous material. Sizes from ¼" to 12" diameter. Made from a variety of metals and alloys to suit innumerable industrial applications.

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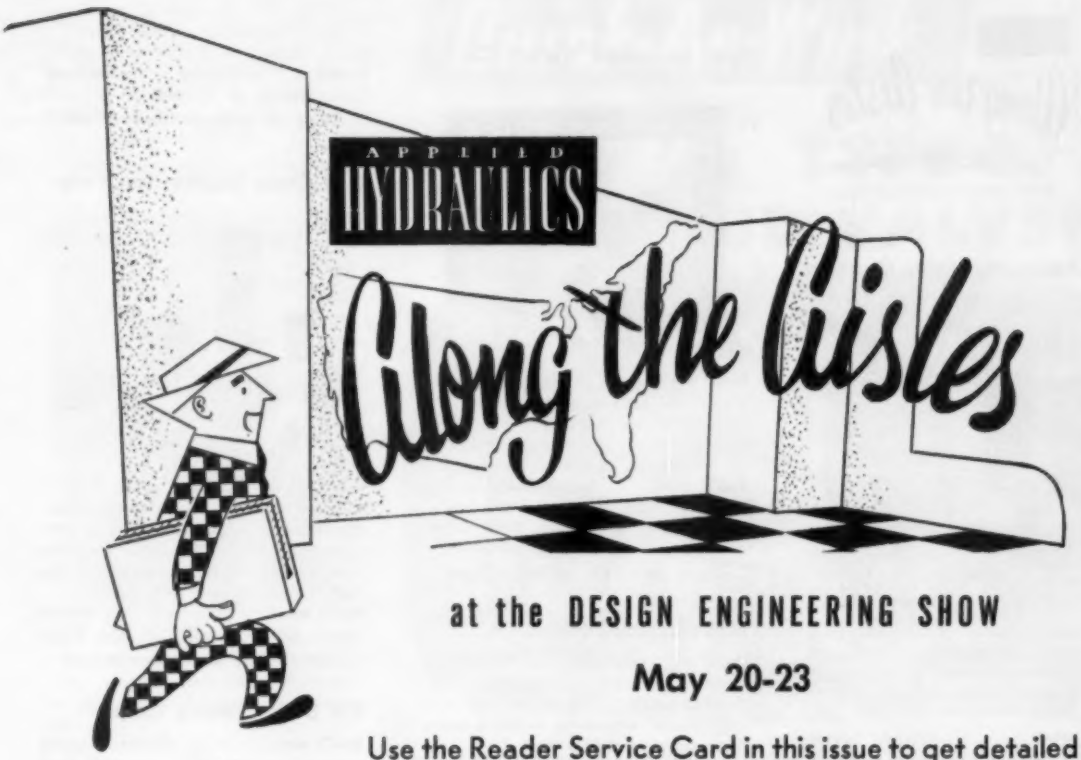

at the DESIGN ENGINEERING SHOW

May 20-23

Use the Reader Service Card in this issue to get detailed information about products exhibited at the exposition

Booth

1408 Acushnet Process Co.

You'll see . . . molded rubber and silicone parts involving various elastomers, molding techniques and applications. Effects of aromatic fuels on polymers will also be shown.
You'll meet . . . Holmes M. Dyer, William Reach, William Ames, William King, Raymond W. Szulik, C. D. Penn, and Miss Louise M. Desaulniers.

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128 Air-Maze Corporation

You'll see . . . an exhibit of air and oil filtration equipment, including air filter panels and water eliminators, Unimaze and Multimaze oil-wetted air filters, oil and fuel filters, dry air filters, exhaust spark arresters, back fire flame arresters and tank vent arresters, breather filters and air line filters.
You'll meet . . . F. P. Purvis, M. Dow, and R. E. Brown.

Circle 181 on Reader Service Card

320 Applied Hydraulics Magazine

You'll see . . . Sample copies of publications such as the Master Catalog of Fluid Power Products, Elmer Heiser's book on Air and Oil Cylinders, Aircraft Hydraulic Design by George Keller, A Beginners Course in Basic Pneumatics, and the Fluid Power Engineering Index.
You'll meet . . . Paul Rolnick, editor and publishing director, and Keith Carlson, associate editor.

Circle 182 on Reader Service Card

728 Benton Harbor Engineering Works

You'll see . . . single and double-acting cylinders with different types of mountings, and a hydraulic flow control valve.
You'll meet . . . R. C. Miller, president, W. L. Miller, secretary, W. L. Leitz and E. J. Krieger.

701 Electro-Snap Switch & Mfg. Co.

You'll see . . . precision snap-action switches, aircraft industrial limit switches, actuators and assemblies, hermetic-sealed switches, basic sub miniature and multi-pole switches.
You'll meet . . . H. F. Ames, George M. Balle, Hank Anderson, Gene Connelly, Kacil Brinn and Al Kramer.

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1643 The Bellows Co.

You'll see . . . a ten-foot air motor which visitors may operate, and other animated pneumatic devices using air motors and hydro-checks.
You'll meet . . . H. B. Link, president, William C. Richards, Jr., vice president, J. J. Mudd and H. Cadieux.

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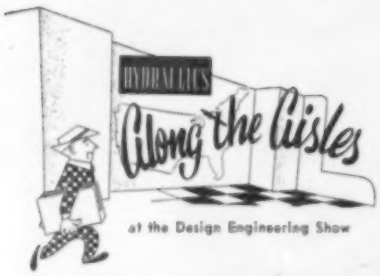
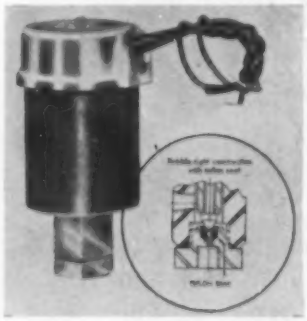


1807 Atkomatic Valve Co., Inc.



You'll see . . . two-way solenoid valves featuring new bubble tight construction for high-pressure, and a transparent working model of a pilot-piston operated valve.

You'll meet . . . Howard R. Taylor, president, and Mark W. Lowe, treasurer.

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1204 Automatic Switch Co.

You'll see . . . an operating display of a new free handle safety shut-off two-way valve, and 2, 3 and 4-way valves operating water and air cylinders. Also, electromagnetic control units.

You'll meet . . . Ted Hacker, George Baumann, Ray Walter, Fred Leyck, Robert Engel, Jack Platt, Jack Evans, R. Buckley, Ray Taylor, Robert May.

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1110 Garlock Packing Co.

You'll see . . . braided and molded mechanical packings, grease seals, mechanical seals, Chevron for hydraulic applications, expansion joints, gaskets, sheet packing, Teflon and Kel-F, and molded and extruded silicones.

You'll meet . . . A. E. Munch, Jr., Ford Wilders, E. G. Baerenrodt, L. L. Burpee, M. F. Gaddis, J. J. Hagmaier, F. C. Morton, J. P. Naughton, E. W. Panhorst, C. H. Simson, M. A. Wunsch.

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1101 Cuno Engineering Corp.

You'll see . . . industrial filters for various applications and particle sizes; Auto-Klean and Super Auto-Klean edge-type, Micro-Klean disposable cartridge type, Poro-Klean with porous stainless steel filter media.

You'll meet . . . James E. Duff, Walter Holder, Ed Kane and D. H. Van Vleck.

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406 Dow Corning Corp.

You'll see . . . new silicone products and applications with demonstrations. Exhibit includes molding compounds withstanding temperatures up to 700 F;

Program Design Engineering Conference

MONDAY, MAY 20

10:00 a.m.—Procedures in Developing New Designs—Question-and-answer panel. Chairman and Moderator: George F. Nordenholt, editor, Product Engineering, New York. Vice Chairman: Charles Marks, member, New York and Patent Bar, New York.

TUESDAY, MAY 21

9:30 a.m.—(Concurrent Sessions)

Mechanical: New Developments in Design and Application of Gearing—Darle W. Dudley, advanced design engineer, gear engineering, General Electric Co., West Lynn, Mass. New Developments in Design and Applications of Cams—Harold A. Rothbart, professor, department of mechanical engineering, College of City of New York.

Materials: Metallic Materials—C. R. Simcoe, principal metallurgical engineer, Battelle Memorial Institute, Columbus, Ohio.
Ceramics and Refractory Materials—John H. Koenig, director, and Edward J. Smoke, professor, School of Ceramics, Rutgers University, New Brunswick, N.J.

Electrical: Selecting Motors With New NEMA Frame Sizes—Earl Barnes, assistant chief engineer, Reliance Electric & Engineering Co., Cleveland.
Static Switching Devices—Dr. Robert A. Mathias, assistant professor, department of electrical engineering, Carnegie Institute of Technology, Pittsburgh.

WEDNESDAY, MAY 22

9:30 a.m.—(Concurrent Sessions)

Mechanical: Designing for Easier Machining, Handling and Assembly—Kurt O. Tech, vice president, engineering, Cross Co., Detroit.
Hopper Feeding—Floyd E. Smith, president, Perry Equipment & Engineering Co., Erie, Pa.

Materials: Plastics and Rubbers—Wyman Goss, manager, phenolics engineering, chemical materials department, General Electric Co., Pittsfield, Mass.
Coatings and Finishes—H. J. Reindl, supervisor, research and development, finishes section, Inland Manufacturing Division, General Motors Corp., Detroit.

Electrical: Numerical Control for Machinery—Claude D. Coffin, senior electrical engineer, Warner & Swasey Co., Cleveland.
Designing Machine Tools for Automatic Controls—C. B. Sung, manager, mechanical development section, research laboratories division, Bendix Aviation Corp., Detroit.

fluorosilicone oil resistant rubber; and the first public showing of Silastic Type K silicone rubber interlayer for windshields in supersonic aircraft.

You'll meet . . . R. E. Vidal, B. A. Thorsberg, R. L. Benfer, F. Delnevo, M. Nakonechny, W. F. Herberg, B. J. Culbertson and E. Earleywine.

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1828 Gast Manufacturing Corp.

You'll see . . . the new Model 4565, rotary-vane air pump, with 45 cfm delivery, for continuous, heavy-duty service as either compressor or vacumm pump.

You'll meet . . . R. G. Wilson, C. A. Baker, William Schwartz.

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1337 Hoke, Inc.

You'll see . . . a complete line of small needle valves, pressure regulators, flogages, check valves and stainless steel cylinders. Also, first showing of a series of metering valves equipped with a vernier for accurate reproductions of previous valve settings.

You'll meet . . . Dr. Wilbur O. Teeters, president, Donald B. Salmon, vice president, and Earl B. Hitchcock, Walter A. Calahan, R. S. Crum, distributor and his men: Donald Pressley, Lester Dotts, William Santos, John Oaks, Gordon Miscall.

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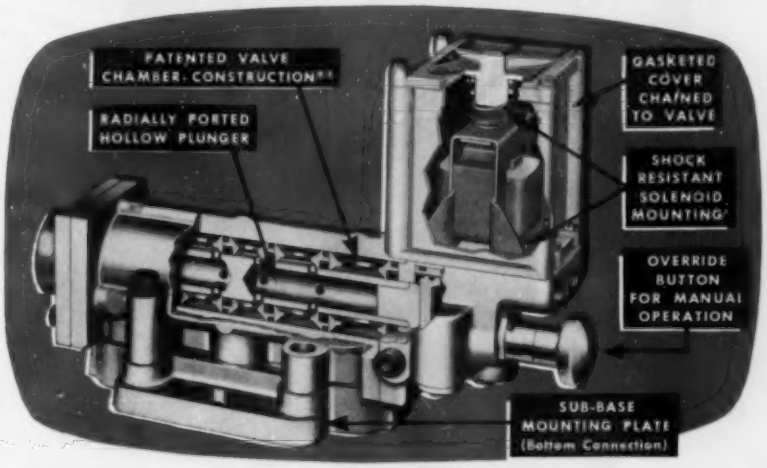
1219 Leiman Bros., Inc.

You'll see . . . a new air-cooled, high-vacuum pump with capacity up to 100 cfm, capable of continuous perform-

Continued on next page

Quick-As-Wink®

JIC ½" TYPE BJ SOLENOID VALVES


PATENTED VALVE CHAMBER CONSTRUCTION**
RADIALLY PORTED HOLLOW PLUNGER
GASKETED COVER CHAINED TO VALVE
SHOCK RESISTANT SOLENOID MOUNTING*
OVERRIDE BUTTON FOR MANUAL OPERATION
SUB-BASE MOUNTING PLATE (Bottom Connection)

offer users many outstanding advantages

Painstakingly designed, ruggedly built and tested for more than 4 years, these new JIC Quick-As-Wink valves combine: —

1) **HIGH FLOW CAPACITY.** The valves have full ½" pipe capacity.

2) **SHOCK RESISTANT SOLENOID MOUNTING*.** Positioning the solenoid with a spring on resilient rubber rings reduces destructive hammering and pounding, greatly increasing solenoid life.

3) **DIE CAST ALUMINUM COVERS** are fully gasketed, mounted with captive screws, and fastened to the valve with a chain.

4) **SUB-BASE MOUNTING PLATE.** Available in two designs so that pipe connections can be made through the bottom or through the side.

5) **PATENTED VALVE CHAMBERS** are formed by aluminum spacers in accurate metal to metal end abutment** that hold the "O" rings and "U" packers in exact position, and supported on both inside and outside diameters, without mechanical pressure. This proven construction permits repacking easily, quickly and accurately in the field.

6) **OVERRIDE BUTTON** permits manual operation in case of power failure.

MANY OTHER OUTSTANDING FEATURES

Also available in 2 position and 3 position Double Solenoid;—2 position and 3 position Lever Operated;— and Single and Double Pilot Operated Designs.

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Write for Bulletin No. 571—Today!

*Patent Applied For **U. S. Patent 2,645,450

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Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

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CHEMLON... the Teflon* solution to your hydraulic cylinder packing problems

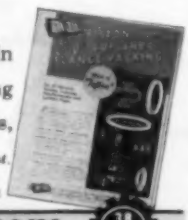
lasts longer in all hydraulic services including non-flammable and synthetic fluids

Once and for all . . . John Crane Chemlon Piston Cup, U-Cup and Flange Packings are the answer to handling *all* types of hydraulic fluids. Molded from chemically inert Teflon, they give positive sealing and long-lasting performance not possible with leather, fabric-reinforced or similar packings.

Heat will not cause these packings to shrink away from the cylinder walls or rod. They will not harden, shrink, swell or in any way disintegrate under higher temperatures often encountered in hydraulic service. Their exceptional thermal characteristics provide an operating range from −94°F. to +350°F.

Here . . . in a wide range of sizes or fabricated to your individual specifications . . . is a complete line of hydraulic packings to meet the need of any operating requirement.

Write to "John Crane" Send now for bulletin giving full technical and application data. Crane Packing Company, 6405 Oakton Street, Morton Grove, Illinois, (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*



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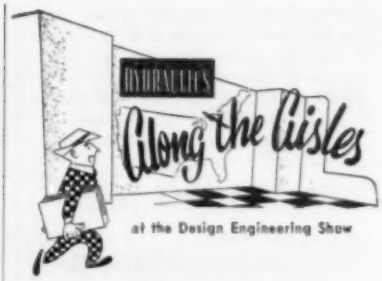

ance 24 hours per day; and integral models of vacuum and pressure pumps.
You'll meet . . . F. N. Haskell, J. R. Whipp, and R. Parmely.

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231 L & L Mfg. Co.

You'll see . . . exhibits of a complete line of fittings for the fluid power industry, including straight-line metallic seal type with captive nut, and other fittings engineered to prevent leakage.
You'll meet . . . G. T. Lyon, president, Tom Lyon, sales manager.

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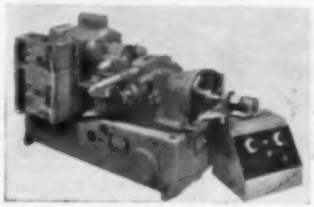
1740 The Oilgear Company



You'll see . . . an electro-hydraulic servo controlled "any-speed" drive and a demonstration of precision speed control from zero to maximum with positive follow-up position control from a remote command unit.
You'll meet . . . C. G. Ellis, A. C. Roecker, A. A. Schulz, M. E Engebretson, from Oilgear; and T R. Porter, J. W. Broome, R. Claflin, Jr., from Servocontrol.

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1138 Parker Appliance Co.

You'll see . . . a full range of fittings; flared, flareless, re-usable, in brass, steel, stainless steel and aluminum; tube-working tools; O-rings, custom

Continued on page 152

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INDUSTRIAL • CHEMICAL • AIRCRAFT

OFFSET GLOBE VALVE

NEEDLE AND GLOBE TYPES
WITH J.I.C. AND AN STANDARD TUBE ENDS

High pressure needle and globe valves by Republic have forged bodies for super duty service—brass, steel, aluminum alloy, or stainless steel. Exclusive design features. Pipe, or AN or J.I.C. tube ends, or combinations, sizes ¼" to 2". Operating range up to 5,000 psi, −65° to 350°F.

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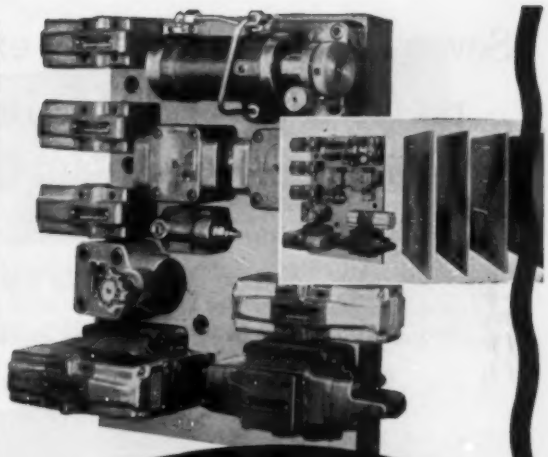

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Leading machine manufacturers use these manifolds to cut costs and obtain permanent trouble-free operation. Send your hydraulic circuit print and sketch showing desired take-off connections. We'll prepare a manifold proposal—No obligation.

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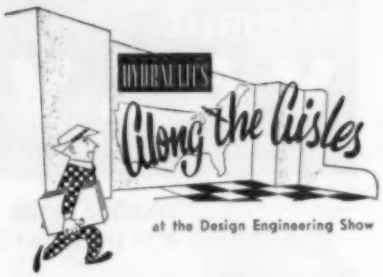

molded parts, special molded floats. Triple-lok straight thread and swivel nut tube fittings.

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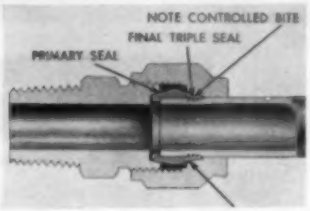
944 Imperial Brass Mfg. Co.



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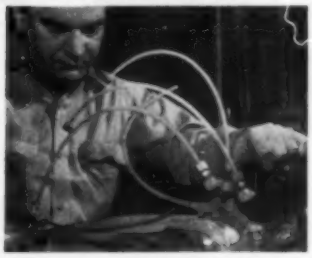
832 The Polymer Corp.



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Continued on page 155

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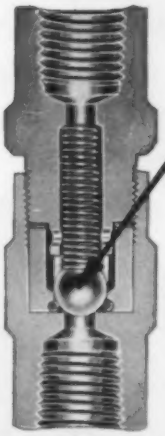

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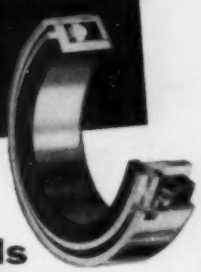

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The SEALOL BALANCED PRESSURE SEAL, incorporating the differential area principle, has proved unusually versatile and efficient in rotary shaft sealing applications of all kinds. If your particular sealing requirements are not listed among the actual sealing applications tabulated here, request Bulletin 7 for complete data.

RPM	Shaft Size	Temperature	Fluid	Pressure
36,000	¾"	200° F	Aviation Fuel	300 PSI
1,800	1⅛"	Room Temp.	Ucon Hydraulic Fluid	1500 PSI
11,000	2¼"	200° F	Lube Oil	20 PSI
6,800	5"	125° F	Lube Oil	Atmos. Pressure
80	2¾"	350° F	Steam & Hot Air	Atmos. Pressure
7,700	5¼"	350° F	Lube Oil	2 PSI
53,000	1"	350° F	Oil & Steam	350 PSI
70,000	½"	230° F	Oil Mist & Air	19" Hg. abs.

Slightly modified versions of the basic Sealol seal make it suitable for almost any rotary shaft sealing application.

RPM	Shaft Size	Temperature	Fluid	Pressure
12,000	2¼"	−300° F	Liquid Oxygen	250 PSI
30,000	1⅛"	125° F	90% Hydrogen Peroxide	60 PSI
14,000	1⅞"	160° F	Fuming Nitric Acid	200 PSI
10,000	⅜"	300° F	Propyl Nitrate	150 PSI

Write us today about your particular problem. Request Bulletin 7 or send blueprints and specifications for speedy Sealol seal-utions. Write now!

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QUICK

WITHOUT the remedy readily at hand, the failure of a hydraulic hose line immediately sets up a costly chain reaction. With varying degrees, this is true not only in construction but in all operations utilizing the many recognized advantages of hydraulic power.

Fortunately, today's engineering advancements have reduced the time loss resulting from such emergencies to a matter of minutes. For example, with Weatherhead quick detachable, reusable and clamp-type hose ends, dependable on-the-job repairs can be made promptly. To further facilitate quick action, Weatherhead coast-to-coast distributors maintain adequate stocks of Weatherhead hose and hose ends to assure you of nearby, dependable service.

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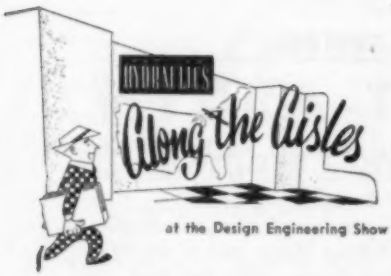
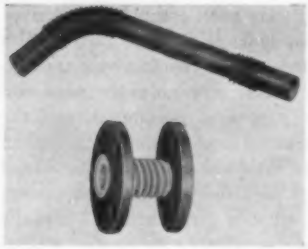


331 Resistoflex Corp.



You'll see . . . Teflon hose for corrosion resistance and high temperature; Teflon laminated pipe combining the chemical inertness of Teflon in fracture-proof pipe for chemical resistance; stress-free Teflon rods, sheets and tubing; Kel-F rods, sheets, tubes, electrical sleeving.
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332 The Weatherhead Co.

You'll see . . . a full line of flareless brass and steel tube fittings, reusable hose ends, bulk hose and hose assemblies.
You'll meet . . . George Anderson, Earl Bartley, Joe Holiger, Warren Mack.

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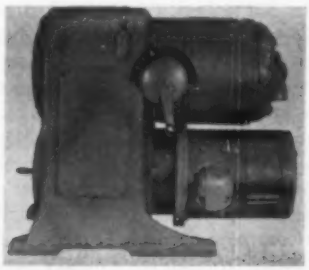

You'll see . . . an exhibit of electrical motors for industry, including horizontal, vertical and totally-enclosed types; gear motors, variable speed motors; and the new Varidyne System for converting standard induction motors into variable speed motors.

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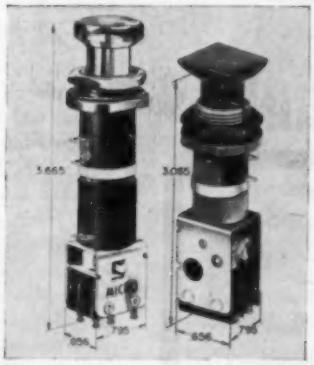
744 Micro Switch, Div. of Minneapolis-Honeywell Regulator Co.



You'll see . . . the new inertia switch applied to an emergency escape light for aircraft; lighted pushbutton switches to reduce space and eliminate holding relays and separate indicator lights, with one model magnetically held and electrically released.

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808 Valcor Engineering Corp.

You'll see . . . working models of various types of solenoid valves, and equipment being operated by the valves.
You'll meet . . . Murray Maslow, Paul J. Smith, Morton A. Kreitchman, vice president, engineering, Joseph J. Barta, George F. Kelly, Alphonso L. LaMastra.

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933 Roller Bearing Company of America

You'll see . . . a cutaway model of an outboard engine and static displays of the Pitchlign bearing and the Self-Aligning Bushing Assembly.
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S.A.E. 45° Flared • Inverted Flared • Pipe • Compression • Selfalign® • Threaded Sleeve • Drain and Shutoff Cocks

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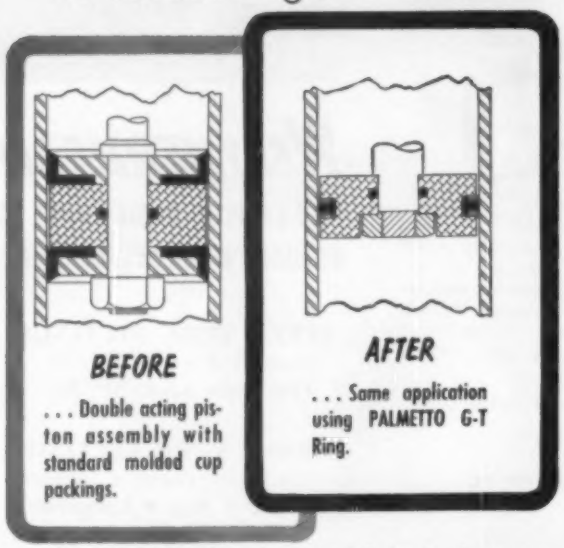
PALMETTO® G-T RING



BEFORE

. . . Double acting piston assembly with standard molded cup packings.

AFTER

. . . Same application using PALMETTO G-T Ring.

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Design Engineers in the hydraulic field are aware of the trend to miniaturization which involves higher pressure and smaller, more efficient components. The G-T Ring is a smaller, more efficient seal. It occupies a minimum space and because of its unique design does not extrude, spiral, twist or roll. It is available in a wide range of standard sizes for rods and pistons and in numerous compounds for hydraulic fluids of all types.

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Resilient T-section supported by non-extrusion rings on either side makes extrusion impossible. As pressure is applied non-extrusion rings are urged against rod or cylinder wall, blocking path of extrusion.

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packing more performance into every application

PALMETTO Packings

GREENE, TWEED & CO.

NORTH WALES, PENNSYLVANIA

WHAT THEY SAY ABOUT LEAKAGE CONTROL

Concluded from page 82

O-ring, metal-to-metal, and jam nut have a definite place. "We must consider heat, vibration, strain, and friction," he said.

Summing up the experience of a large hydraulics user, J. E. Merkle of Ford Motor said at the 1956 Vickers Machine Tool Forum, "We feel that the new internal straight thread fitting with supplemental seal fills a need in hydraulics as applied to machine tools . . . It has been estimated that over 50% of our external leakage is attributed to the use of tapered pipe threads. In replacing the tapered pipe thread, the new fitting eliminates the need and the shortcomings of a sealing compound, and the difficulties in positioning and sealing other than straight type fittings. We have approved the thread form . . . and have published a standard recommending its use in all new construction hydraulic operated equipment."

One obstacle to a complete changeover to straight threads is the present standardization on tapered thread ports in valves and other components. Components with straight thread ports are on the way —sub-plates are available now as well as some of the more popular pumps.

• **Eliminate Joints**—One of the best ways of controlling leakage from fluid line joints is by *eliminating* them—using drilled, welded, or brazed manifolds. Drilled and welded manifolds are being used extensively and brazed manifolds are coming into increased use.

Some of the machine tool manufacturers are manifolding all valve connections and using piping only for fluid lines to cylinders. In some cases these manifolds are mounted on the tank so that no external piping is required. More about manifolds in *Use of Valve Manifolds* on page 94.

• **Why Not Just Let It Leak?**—In our editorial travels we've seen scores of hydraulic machines surrounded by sawdust, tin cans, rags, and various other compromises with the leakage problem. Some leakage is inevitable, but unless it is controlled it can be an extremely costly matter of replacement oil, damaged production, and downtime. To our questions of how much of your oil gets scraped up with a squeegee, and how much of your yearly usage does this represent, we got some very startling answers all the way up to 400,000 gallons representing 60% of a large automotive manufacturer's yearly requirement. Actually few operators and maintenance supervisors keep accurate records, but from talking with users around the country AH editors estimate yearly make-up oil requirements in many cases are 100% of the total oil in use.

This great loss indicates that many machine designers, builders and maintenance engineers are not aware of, or are not taking the initiative to use new products and proven leakage control techniques. ▼▼▼

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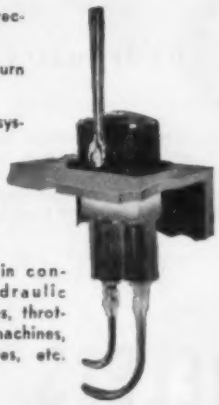
CROWN HYDRA-TROL Remote Control

- Has positive stroke in both directions.
- Does not depend on spring return or outside power sources.
- Immediate synchronization of system in either direction.
- Is a self-contained hydraulic system for positive positioning of remotely-located levers, shafts, and other equipment.



- Valuable in controlling hydraulic valves, winches, throttles, slitting machines, butterfly valves, etc.

Write for bulletin A describing the control and showing its many uses.

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VACUUM PUMP: 45 c.f.m., vac. to 25 in. hg. with 3 h.p. motor, 35 c.f.m. with 2 h.p.

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Now ..... bigger–volume utility for original equipment or plant use! Built as either Compressor or Vacuum Pump for continuous, heavy-duty service. Air-cooled by 10" diameter pitch fan. Cowl-guard directs air—eliminates water-cooling headaches.

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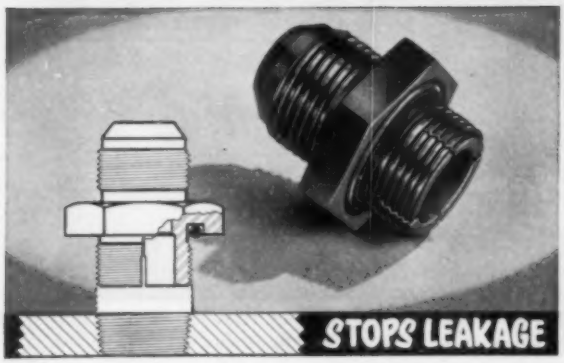

PETCH-HUPP *Ring-Wedge Adapter*

STOPS PIPE THREAD LEAKAGE *without specifying straight thread*

- Use with standard tapered female pipe threads
- No special tools required
- Tube end utilizes standard 37° Flare fitting elements
- RING-WEDGE male thread slotted allowing O-ring seal contact independent of port thread depth
- O-ring does not interfere with threads
- O-ring seals on port boss-spot face optional—no pipe sealing compound required

Part No.	Tube O.D.	Used w/ NPTF
821RW 4	1/4"	1/8"
821RW 6	3/8"	1/4"
821RW 6-6	3/8"	3/8"
821RW 8-4	1/2"	1/4"
821RW 8	1/2"	1/2"
821RW 8-8	1/2"	3/4"
821RW 8-12	1/2"	1"
821RW 10	5/8"	1/2"
821RW 12	3/4"	1/2"
821RW 14	7/8"	3/4"
821RW 16	1"	1"
821RW 20	1 1/4"	1 1/4"
821RW 24	1 1/2"	1 1/2"
821RW 32	2"	2"

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- **Protect against thread damage, dust, dirt, and moisture.**
- **For inside and outside application. All sizes. Immediate delivery.**

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PLASTIC Tapered parts for use either as a cap or plug.

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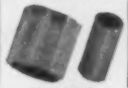

PLASTIC (L.T. Series) Non-threaded push-on caps for tubing, AN & SAE Fittings, reamers, etc.

Clover closures are made in metal and tough plastic polyethylene. They are made in caps, plugs and special shapes to fit parts tightly, offering completely sealed protection during manufacture, shipping and storage. Backed by years of closure experience. Write for low prices and complete information.

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SELECTION OF FLARELESS FITTINGS

. . . for aircraft circuits

• By Kenneth Clarke

Leakage in the hydraulic system of a modern airplane can have disastrous results, and reliability depends as much on the simple tube fittings as the complex pumps and valves. Because they are easily used with hard stainless tubing and can be largely fabricated from aluminum alloy, flareless fittings, now in quantity production, have distinct advantages for aircraft systems.

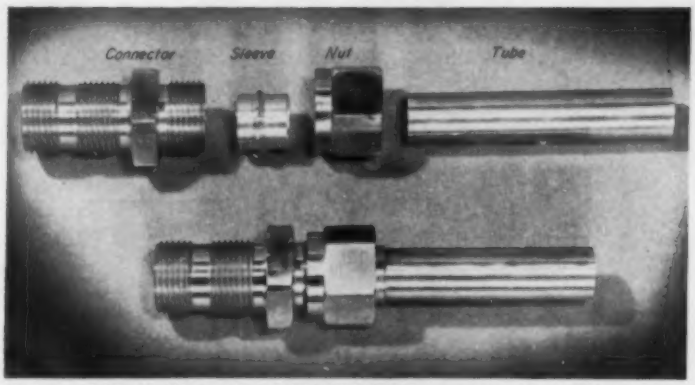


FIG. 1. ASSEMBLED AND DISASSEMBLED MS flareless fittings show the nut, sleeve and connector which make up the fitting.

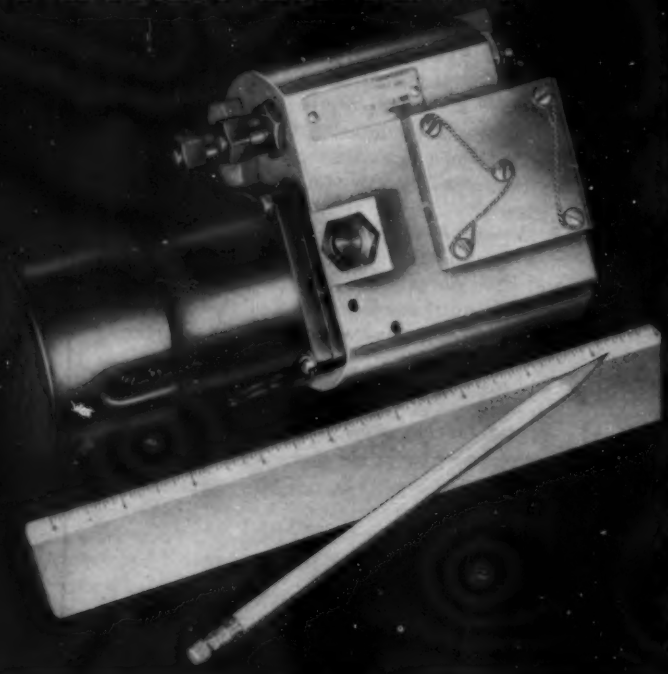
MODERN aircraft hydraulic systems are well designed and should give reliable service. Yet there are, many circuit failures due to leakage of the relatively simple tube fittings rather than failure of the more complex circuit components. Leakage in the hydraulic system of an aircraft can have very serious consequences. Therefore, it is important that the hydraulic designer give as much consideration to fitting selection as is given to selection of other components.

A relative newcomer to the field of aircraft hydraulic system fittings, the MS flareless fitting, seems to be a solution to the leakage problem in today's high-performance aircraft. Under development for some years, these fittings were not, until quite recently, adaptable to mass-production aircraft applications. This type of fitting is pres-

KENNETH CLARKE, *Senior Test Engineer, Check Valve and Fittings Div. Laboratory, Parker Aircraft Co., Los Angeles, Calif.*

Circle 46 →

AIRCRAFT-TYPE
hydraulic
POWER UNITS . . .



To supply dependable hydraulic power for critical applications, Eastern units are engineered to perform under extreme conditions. Compact design and varying motor sizes make them unique power sources, especially desirable for airborne use. The equipment illustrated in detail presents a typical Eastern Power Unit designed for one application. Many other requirements can be satisfied with designs of this general type.

Unit consists of: positive-displacement pump, electric motor drive, oil-reservoir, expansion chamber, porous bronze ten-micron filter, pressure regulating valve, filter relief valve, and expansion relief valve.

SPECIAL UNITS to be built into Servo Systems and specialized projects are available. As illustrated below, Actuators combined Servo-valve and Actuator, and Servo-valve Hydraulic System combinations are being produced by Eastern for custom-specified jobs. If your project involves equipment of this type, write to us for further information.

Specifications:

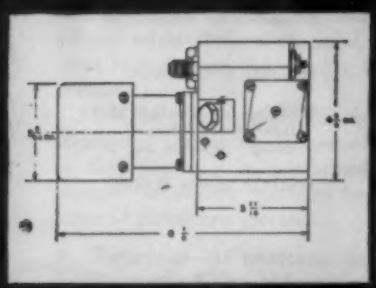
Available with either 1/8, 1/4, or 1/2 horsepower motor, in 28 V. D.C. or 400 Cycles 3 Phase power.

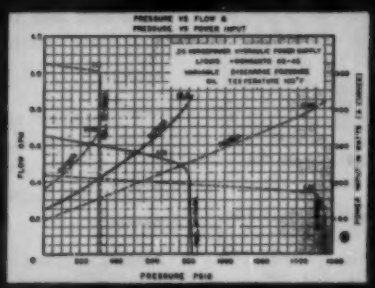
Available with various pump characteristics.

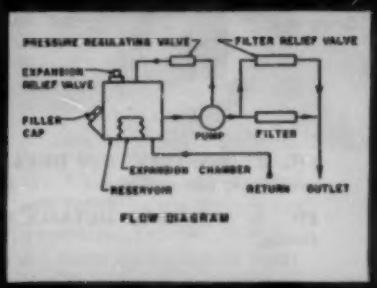
Under certain operating conditions, units can be made self-cooling. *Example:* 1/4 H.P. Unit has a continuous-duty oil-temperature rise above ambient of approximately 60 F. at sea level.

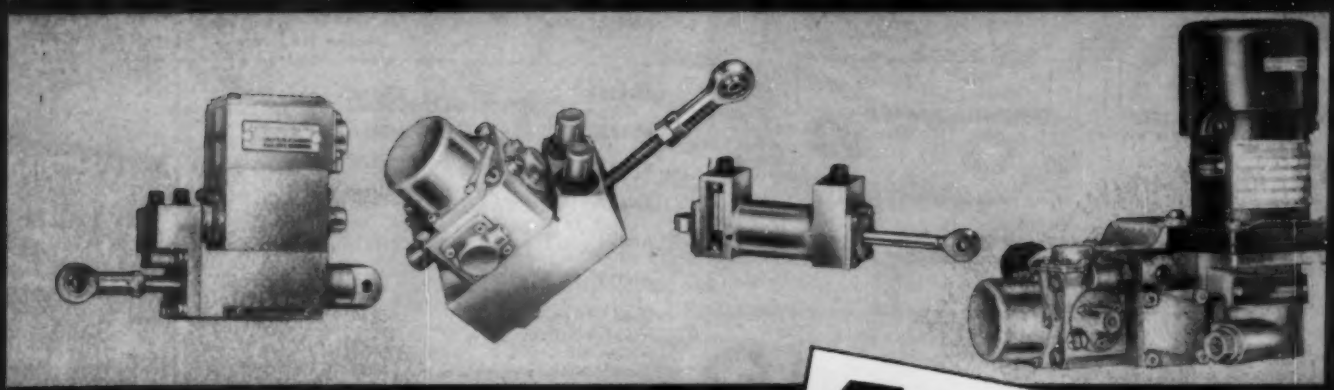
Pressure range from 0 to 1500 PSIG with compatible flow.

Anodized aluminum body contains all components except motor.









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SELECTION OF FLARELESS FITTINGS

. . . for aircraft circuits

• By Kenneth Clarke

Leakage in the hydraulic system of a modern airplane can have disastrous results, and reliability depends as much on the simple tube fittings as the complex pumps and valves. Because they are easily used with hard stainless tubing and can be largely fabricated from aluminum alloy, flareless fittings, now in quantity production, have distinct advantages for aircraft systems.

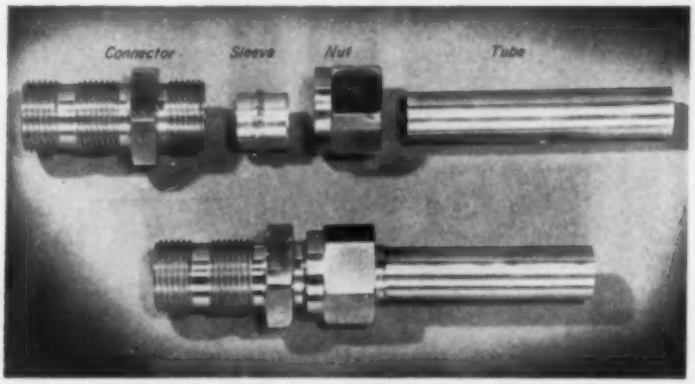

FIG. 1. ASSEMBLED AND DISASSEMBLED MS flareless fittings show the nut, sleeve and connector which make up the fitting.

MODERN aircraft hydraulic systems are well designed and should give reliable service. Yet there are, many circuit failures due to leakage of the relatively simple tube fittings rather than failure of the more complex circuit components. Leakage in the hydraulic system of an aircraft can have very serious consequences. Therefore, it is important that the hydraulic designer give as much consideration to fitting selection as is given to selection of other components.

A relative newcomer to the field of aircraft hydraulic system fittings, the MS flareless fitting, seems to be a solution to the leakage problem in today's high-performance aircraft. Under development for some years, these fittings were not, until quite recently, adaptable to mass-production aircraft applications. This type of fitting is pres-

KENNETH CLARKE, *Senior Test Engineer, Check Valve and Fittings Div. Laboratory, Parker Aircraft Co., Los Angeles, Calif.*

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AIRCRAFT-TYPE
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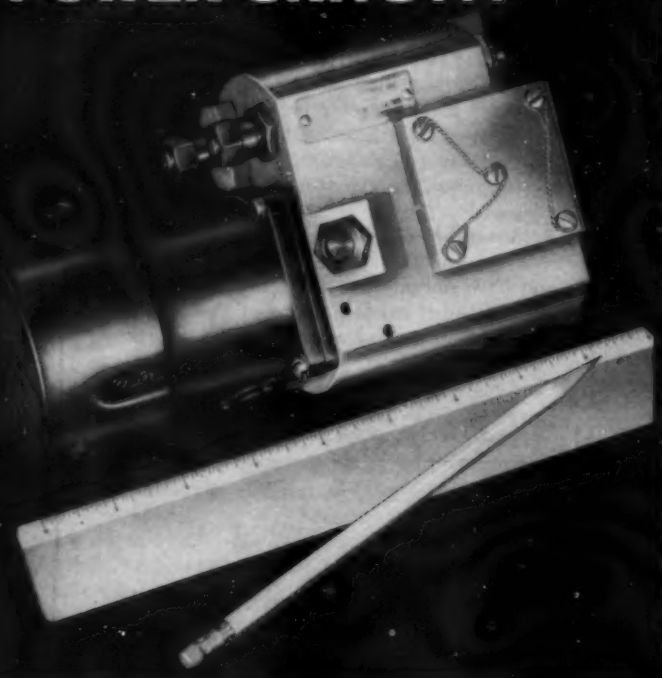
POWER UNITS . . .



To supply dependable hydraulic power for critical applications, Eastern units are engineered to perform under extreme conditions. Compact design and varying motor sizes make them unique power sources, especially desirable for airborne use. The equipment illustrated in detail presents a typical Eastern Power Unit designed for one application. Many other requirements can be satisfied with designs of this general type.

Unit consists of: positive-displacement pump, electric motor drive, oil reservoir, expansion chamber, porous bronze ten-micron filter, pressure regulating valve, filter relief valve, and expansion relief valve.

SPECIAL UNITS to be built into Servo Systems and specialized projects are available. As illustrated below, Actuators combined Servo-valve and Actuator, and Servo-valve Hydraulic System combinations are being produced by Eastern for custom-specified jobs. If your project involves equipment of this type, write to us for further information.

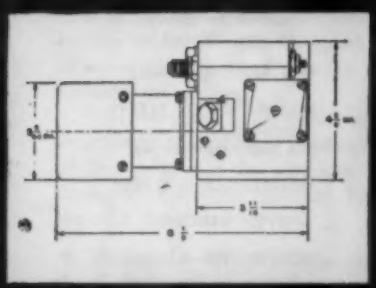
Specifications:

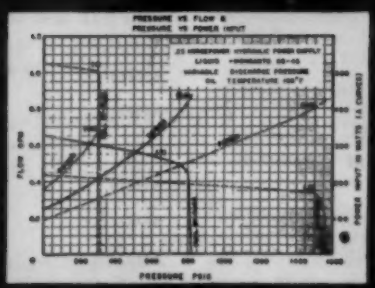
Available with either 1/8, 1/4, or 1/2 horsepower motor, in 28 V. D.C. or 400 Cycles 3 Phase power.

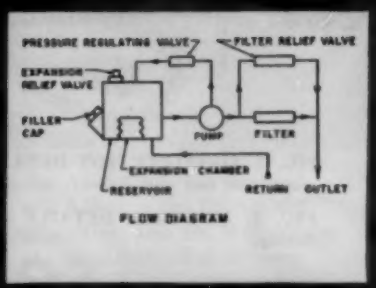
Available with various pump characteristics. Under certain operating conditions, units can be made self-cooling. *Example:* 1/4 H.P. Unit has a continuous-duty oil-temperature rise above ambient of approximately 60° F. at sea level.

Pressure range from 0 to 1500 PSIG with compatible flow.

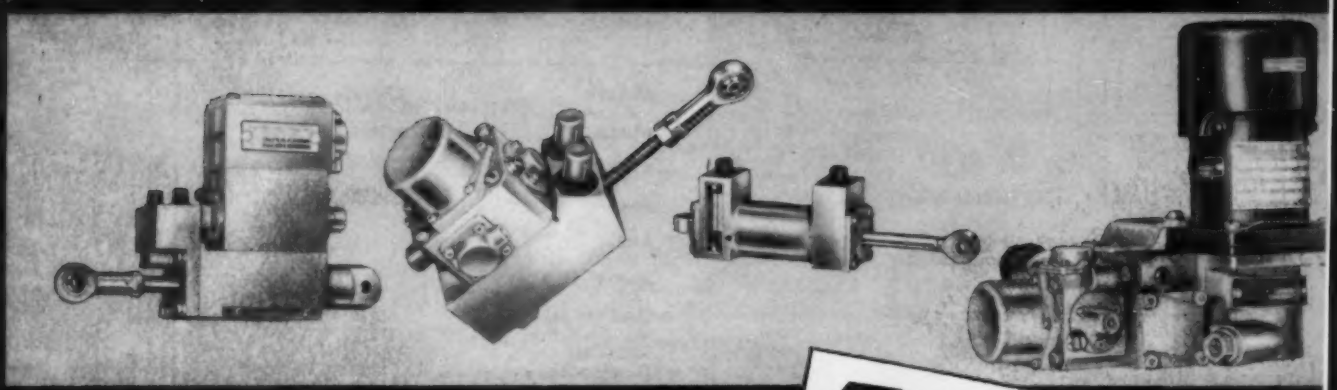
Anodized aluminum body contains all components except motor.







FLOW DIAGRAM



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ently being used in production of the Lockheed F-104 and is also on the latest prototypes. Successful installations of these fittings have caused the military service to specify them as standard for use on all future aircraft. Many commercial airline operators are now specifying this fitting for their latest jet and turboprop aircraft.

• **What They Are**—MS flareless fittings are made up of three separate parts, a connector, sleeve and nut, Figure 1. Connectors are available as adapters, unions, elbows, tees, etc, and have external threads and an internal, conical sealing surface, Figure 2*a*. At the base of the conical seat, there is a straight counterbored section which guides the tube end as it is inserted. A 15-degree reverse-angle tubing seat at the base of the straight counterbored section prevents inward collapse of thin-wall tubing as the fitting is tightened.

At the base of the internal thread of the coupling nut, there is a 45-degree bevel which transmits the tightening force to the sleeve so as to cause it to cut into the tubing as the sleeve is tightened and produce a cut in the tubing, Figure 2*b*. Sleeves are fabricated from steel and cyanide case hardened to a depth of 0.0015 to 0.0019 in., to insure an effective cutting edge, Figure 2*c*.

• **Assembly**—Ends of tubes to be assembled with flareless fittings should be reasonably square and have no external scratches or dents. Any external distortion of the tube at the end may result in leakage past the sleeve by preventing a

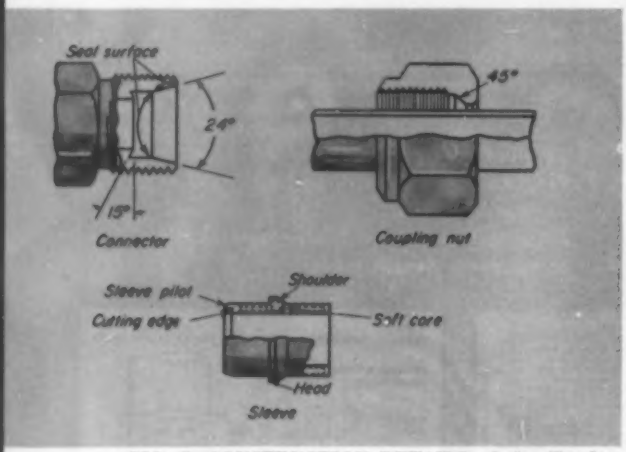


FIG. 2. CONSTRUCTION DETAILS of the flareless connector, nut and sleeve.

FIG. 3. ASSEMBLY DETAILS of the MS flareless fitting.

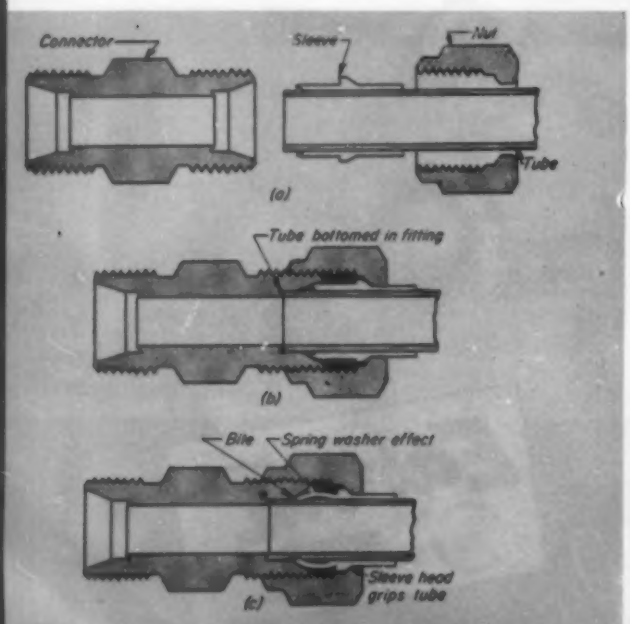


TABLE I

MS and Equivalent AN Fitting Designations

AN783	MS21910 TEE
AN784	MS21911 TEE
AN804	MS21912 TEE
AN806	MS21913 PLUG
AN815	MS21902 UNION
AN817	MS21917 LONG NUT Inactive for future design, replaced by
AN818	MS21921 SHORT NUT
NONE	MS21918 SHORT SLEEVE Inactive for future design, replaced by
AN819	MS21922 LONG SLEEVE
AN821	MS21904 UNION
AN824	MS21905 TEE
AN827	MS21906 CROSS
AN832	MS21903 Inactive for future design, replaced by
AN832	MS21924
AN833	MS21908 ELBOW
AN834	MS21909 TEE
AN837	MS21907 ELBOW
AN894	MS21915 BUSHING
AN919	MS21916 REDUCER
Used for changing system from AN to MS. Therefore there is no AN equivalent.	MS21900 ADAPTER MS21901 ADAPTER Inactive for future design, replaced by MS21923 ADAPTER

proper fit of the sleeve on the tubing. All burrs and sharp edges should be removed from inside and outside of the tube end. However, there should be no appreciable chamfer.

First the nut and then the sleeve are placed on the prepared tube end, Figure 3*a*. The tube end is then inserted in the connector until it bottoms, Figure 3*b*. The nut is then tightened until a sharp increase in tightening torque is felt. This indicates that the sleeve has seated. A further 1/6 to 1/3 turn of the nut completes assembly. It is expected that in the future, proper torque wrench settings will be published for correct tightening. Another alternative being considered is the provision of stripes on nut and connector which will be aligned when the nut is properly tightened.

As the nut is tightened, the sleeve is diven forward by the nut until it contacts the conical sealing surface of the connector. Further tightening then causes the bevel of the nut to bear against the sleeve head and compress the sleeve against the tubing at a point directly under the sleeve head. At the same time, the sleeve end is guided by the connector bevel into contact with the tubing where the cutting edge bites into the tubing. With the sleeve held at the point of the cut, continued tightening bows the sleeve into contact with the connector to form a leakproof seal, Figure 3*c*. Bowing of the sleeve also supplies a spring washer effect to resist loosening of the nut.

In the properly assembled fitting, the tube is held at the sleeve head, the connector seat and the cutting edge. This three-point support provides effective resistance to loosening from vibration and pressure pulsations.

After the first assembly, the sleeve is permanently attached to the tubing. Disassembly and reassembly of the joint can be performed with no loss of strength or sealing qualities because of the resilience of the sleeve.

• **Materials**—All flareless fitting parts except the sleeve can be made from any desired material. Titanium, steel, stainless steel and aluminum alloy nuts and connectors are produced. Sleeves must be of steel or stainless steel to provide the required cutting edge and resiliency. Aluminum alloy parts are commonly anodized in a natural gray or yellow. Steel parts have a natural cadmium finish.

• **Part and Size Designation**—Designation numbers for the various flareless fitting parts are given in Table I along with designations of the AN flare fittings which they may be used to replace. Size is indicated in the usual manner by appending a dash number which corresponds to the OD of the tube in sixteenths of an inch. For example, a 3/8-in. OD union would be designated, MS 21902-6.

TABLE II

Fitting Materials and Designation

Material	Designation
Aluminum Alloy	D
Carbon Steel	None
302, 303, 304, 316, 321 Stainless Steel	C
304L and 347 Stainless Steel	S
Titanium	T

Material indication is effected by placing a letter after the basic part number. Letter designations and the corresponding materials are given in Table II. If the previously mentioned connector were of aluminum, it would be designated MS 21902D-6.

• **Cost**—Although the cost of the MS fitting is presently higher than the AN fitting, it is expected that price reductions will follow as the fittings are produced in greater quantities. For the moment, costs of these fittings are more than offset in many instances by their reliability, lower maintenance costs and increased system safety. ▼▼▼

About the Author . . .

Kenneth Clarke

. . . . Ken Clarke, author of this article on MS flareless fittings, has been directly concerned with all phases of the development of these fittings in his position as senior test engineer in charge of Parker Aircraft's Check Valve and Fittings Div. Laboratories. Ken has had over fifteen years experience in the fluid power field. He has worked on the development of hydraulic and fuel filters and after the war joined the Hydraulic Brake Co. to work on the development of hydrauli_ systems and components. Before his present assignment, Ken was in charge of Parker's central development laboratory.

Air intended for operation of pneumatic equipment must be clean. When the people at McDonnell Aircraft Corp. discovered powdered dessicant, water, and oil droplets in the lines from 3000-psi aircraft ground-service compressors, they worked out a system to assure elimination of these contaminants and the possibility of contaminating the aircraft system. Here's the method they use.

CONTROL OF CONTAMINANTS

...from aircraft ground service compressors

● By Emil Struharik

CONTROL of contaminants in compressor discharge lines is not difficult in concept. All that is necessary is to select the proper filters and then change them at proper intervals. However, methods for doing this and human nature being what they are, achievement of this result is a bit more difficult. System design and procedures to produce the required result will be described in detail starting with the water removal techniques.

● **Water Removal**—New compressors were purchased with automatic blowdown of water separators. Blowdown occurred when pressure setting was reached and the compressors unloaded interstage. Existing compressors were modified to incorporate this feature.

Water separator capacity was determined from an anlysis of normal running time. Although the predominant length of run was found to be from 3 to 4 minutes, it was observed that running time was frequently 20 minutes or more. Therefore water separators with capacity for a continuous run of one hour were selected.

In order to determine the actual capacity corresponding to an hour's running time, it was necessary to obtain humidity figures from the local U. S. Weather Bureau for a period of years and determine an average figure for the particular locality. When the compressors are to be used indoors an average humidity for the plant involved has to be determined.

An efficiency of 90 percent was assumed for the water separators. This is somewhat less than claimed efficiency. However, the additional capacity installed for this reason is an important safety factor. To remove the additional 10 percent moisture and obtain dry air, two dessicant cartridges are installed in the discharge line from the compressor, Figure 1.

Dessicant selected and presently being used is anhydrous calcium sulfate. Characteristics of this

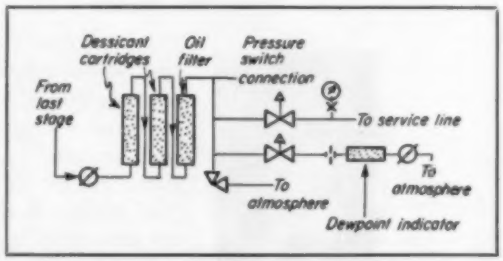
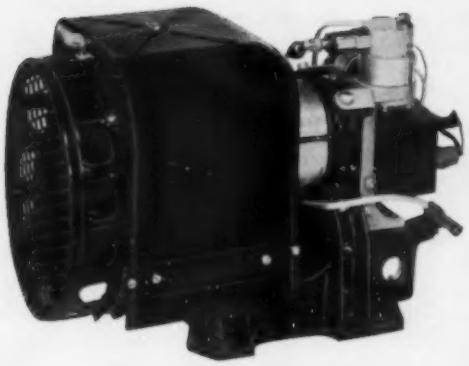
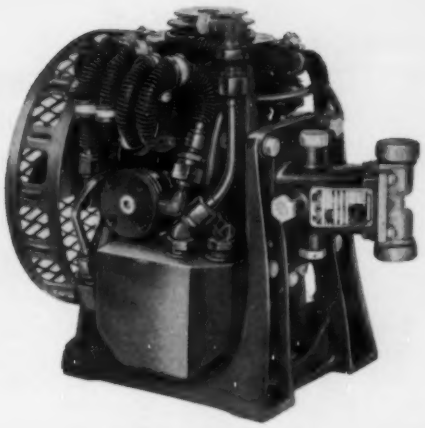


FIG. 1. AIR PURIFYING CIRCUIT to remove oil and moisture from 3000-psi aircraft ground service compressor discharge.

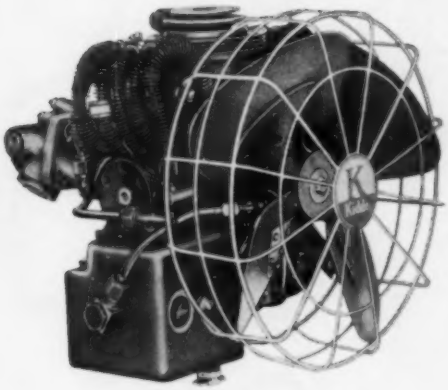
EMIL STRUHARIK, *Methods Engineer, McDonnell Aircraft Corp., St. Louis, Missouri*



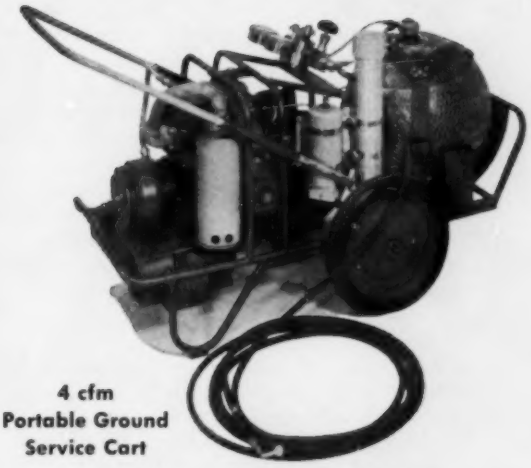
2 cfm Compressor Package



4 cfm Compressor



6 and 8 cfm Compressors



4 cfm
Portable Ground
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material and other dessicants are compared in Table I. Despite the comparatively low moisture absorption by weight of the calcium sulfate, its cost and relatively constant rate of activity over its useful life over a wide temperature range dictated its use. Testing of other dessicants will, however, continue.

Dessicant powder present in the system was discovered to be the result of faulty manufacture and possibly rough handling. To eliminate this difficulty, the manufacturer now supplies cartridges having twice the previous depth with an increased grain size. Shipping packages are now cushioned.

With the proper equipment selected to provide dry air, there still remained the problem of proper maintenance. To assure that the dessicant cartridges would be changed at proper intervals, a timer was connected into the control circuit to shut the compressor down when cartridge life was at an end, Figure 2. A red warning light is also incorporated in the circuit to warn operating personnel of the impending shutdown one-half hour before it occurs. The timer is started and stopped by a pressure switch so that it functions only while the compressor is loaded. The timer is in a wire-sealed case to keep operating personnel from exceeding safe time. Maintenance personnel are responsible for changing the cartridges, resetting the timer and noting the change on a card attached to the timer.

As a means of verifying the efficiency of water removal, a dew point indicator is incorporated in the circuit. Maintenance personnel are required to check after replacing dessicant cartridges to see that air delivered has a dewpoint near — 70°F. In addition, both supervisory and quality control personnel are instructed to check the quality of the air using the dew-point indicator at the start of each shift and at intervals throughout the shift to see that the dew point goes no higher than — 40°F. In the event that it does, the compressor is shut down and dessicant cartridges changed.

• **Oil Removal**—Since the dessicant cartridges have negligible value so far as oil absorption is concerned, an oil-absorptive in cannister form is installed on the downstream side of the dessicant cartridges. Maintenance personnel are instructed to inspect the oil filter at the third and fourth dessicant cartridge changes for excessive oil. Cartridges are changed at every fifth dessicant cartridge change. When inspection of the cartridges shows a need for replacement at the fourth dessiccant cartridge change, the compressor is overhauled to eliminate excessive oil consumption.

▼▼▼

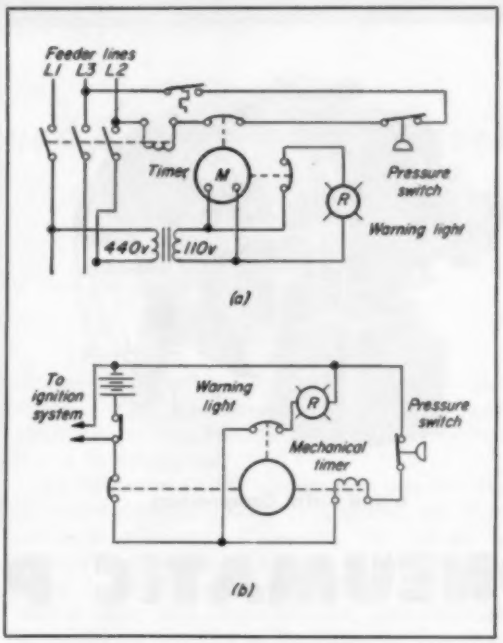

FIG. 2. TIMERS AND WARNING LIGHTS are used to warn of the end of dessicant life. Red lights go on to warn of impending shut down one-half hour before the timer shuts the compressor down. Circuit for electric motor drive at *a*, for gasoline engine drive at *b*.

TABLE I

Dessicant Cartridge Comparison

DESSICANT	ABSORPTION AT 40% RELATIVE HUMIDITY (% BY WEIGHT)	WEIGHT (LB/CANNISTER)	RELATIVE ABSORPTION*	RELATIVE COST*
Silica gel	20	1.3	1.4	3.2
Calcium Sulfate	10	1.75	1.0	1.0
Activated alumina	12	1.6	1.0	7.5
Molecular sieve	19	1.5	1.5	7.5

*Minimum = 1.0

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5	22	39	56	73	90	107	124	141	158	175	192	209	226	243	260	277	294	311	328
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3	20	37	54	71	88	105	122	139	156	173	190	207	224	241	258	275	292	309	326
4	21	38	55	72	89	106	123	140	157	174	191	208	225	242	259	276	293	310	327
5	22	39	56	73	90	107	124	141	158	175	192	209	226	243	260	277	294	311	328
6	23	40	57	74	91	108	125	142	159	176	193	210	227	244	261	278	295	312	329
7	24	41	58	75	92	109	126	143	160	177	194	211	228	245	262	279	296	313	330
8	25	42	59	76	93	110	127	144	161	178	195	212	229	246	263	280	297	314	331
9	26	43	60	77	94	111	128	145	162	179	196	213	230	247	264	281	298	315	332
10	27	44	61	78	95	112	129	146	163	180	197	214	231	248	265	282	299	316	333
11	28	45	62	79	96	113	130	147	164	181	198	215	232	249	266	283	300	317	334
12	29	46	63	80	97	114	131	148	165	182	199	216	233	250	267	284	301	318	335
13	30	47	64	81	98	115	132	149	166	183	200	217	234	251	268	285	302	319	336
14	31	48	65	82	99	116	133	150	167	184	201	218	235	252	269	286	303	320	337
15	32	49	66	83	100	117	134	151	168	185	202	219	236	253	270	287	304	321	338
16	33	50	67	84	101	118	135	152	169	186	203	220	237	254	271	288	305	322	339
17	34	51	68	85	102	119	136	153	170	187	204	221	238	255	272	289	306	323	340

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Protecting bearings in many types of aviation mechanisms

Johns-Manville's precision-moulded Clipper Oil Seals retain lubricant and exclude dirt. These seals have a dense asbestos-compound heel and a soft flexible lip concentrically moulded into one unit. This unique construction provides maximum sealability, low torque, easy installation, long life and wide adaptability. Some of their applications include:

In Actuators—In the worm gear drive of hydraulic actuators, Clipper Seals prevent oil leakage at shaft speeds of 0 to 9000 RPM, pressures of 0 to 20 psi and temperatures of –60 F to 250 F . . . with a maximum seal drag of 4 oz. Sketch shows seals used in tandem with specially developed metal adapter ring. Here, Clipper Seals replaced a far more costly seal, maintained high performance.

In Constant Speed Propellers—Used on the blade retaining nut of constant speed propellers, J-M Clipper Seals maintain a tight seal against the 400 psi pressure created by the propeller's velocity. Clipper Seals' light shaft drag permits rapid pitch changes.

Clipper Seals have also provided outstanding service in tests by major airlines in accessory drive gear trains.

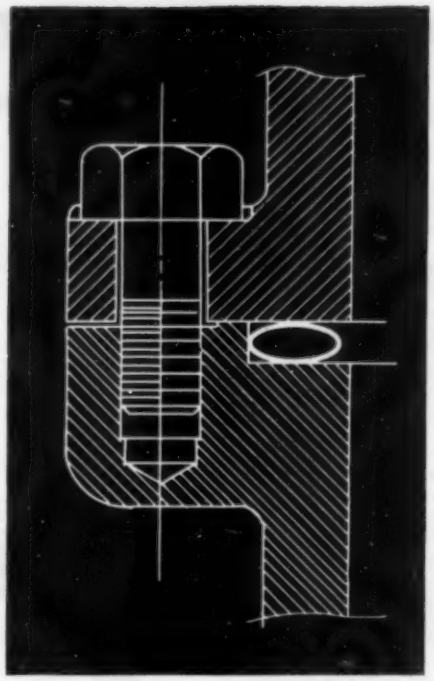
In Crankshaft Assemblies
Johns-Manville developed a special split seal to permit use of an economical flange-type crankshaft in a popular engine used in small planes.

In Bearing Mechanisms—High sealability and low friction at high shaft speeds make Clipper Seals particularly suitable for clutch and transmission bearing mechanisms in helicopter rotors.

If you have an oil seal problem, Johns-Manville will be glad to help you solve it. For engineering help and free 28-page illustrated brochure PK-71A, write Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS **Johns-Manville CLIPPER SEALS**

What static seals are being used for high temperature and high pressure conditions on aircraft and missile systems? Introduced more than 20 years ago in Great Britain, the metal O-ring today helps prevent hydraulic leakage on many critical applications.



STATIC SEALING WITH METAL O-RINGS

. . . for high temperatures and pressures

NEED for a static seal which is reliable over a wide range of temperature has led to the use of the metal O-ring in the aircraft industry. On missile applications, hydraulic fluid temperatures are approaching 500°F and aimed higher; pressures are aimed beyond 3000 psi.

• **Types**—Stainless steel thin-wall tubing material is standard for metal O-rings used in hydraulic circuits. Rings have also been made from other metals: mild steel, aluminum, copper, iconel and monel. Plating rings with a soft covering is sometimes done to compensate for groove irregularities.

One type of metal O-ring is pressure filled with an inert gas at 600 psi. This design will seal very high pressures at normal temperatures. At temperatures in excess of 500°F, pressures fall well below 500 psi.

The second type is called self-energized because this O-ring has tiny holes drilled through the ID face to allow the contained pressure to enter the ring. A balance of pressures exists across the inside diameter of the O-ring to prevent collapsing of the tube. An unbalance of pressure forces exist across the sealing surface to increase the resilience of the O-ring. This type of ring is being used to form a pressure tight joint between two flat machined surfaces at temperatures from —70 to 1800°F and pressures up to 10,000 psi.

• **Sealing Requirements**—Five requirements must be met to obtain a tight seal with the self-energized metal O-ring:

1. A mechanical back-up for the O-ring
2. Correct O-ring squeeze
3. Sufficiently smooth groove surface
4. Sufficient compression-load to install the O-ring
5. Limitation to the deflection of the groove surfaces

Mechanical backup prevents pressure from overstressing the O-ring in hoop tension. When the O-ring is sealing pressure from the inside diameter to the outside diameter, the backup is the part of

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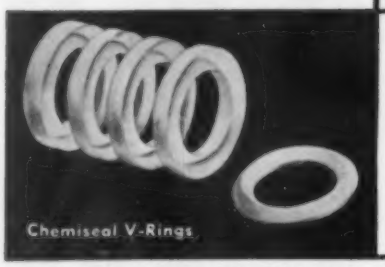

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United States Gasket *Plastics Division*
OF THE GARLOCK PACKING COMPANY

METAL O-RINGS

AVIATION

the O-ring groove which contacts the outside diameter of the O-ring.

Amount of O-ring squeeze affects the cracking pressure which is the pressure at which the deflection of the flange faces exceeds the resilience of the O-ring. Amount of squeeze also influences the tendency for localized low pressure leaks and affects the allowable tolerance on the OD of the O-ring and the OD of the groove. Approximately 15% squeeze results in maximum cracking pressure.

Depth of the O-ring groove also affects the allowed tolerance on the OD of the O-ring and the OD of the O-ring groove. This is because the percentage of O-ring squeeze determines the amount the outside diameter of the O-ring will expand when compressed into the O-ring groove.

Surface for a tight seal depends on hardness of the surface, wall thickness of the O-ring, and the character of the machined surfaces. Here is the standard set-up for surface finish:

1. Circular tool mark only
2. A 32 rms finish for a liquid tight joint
3. A 32 rms finish with plating on the O-ring for a gas tight joint.
4. A 63 rms finish for heavy wall O-ring in screw applications.

● **Limitations**—In each application, the limitation in pressure is a result of excessive deflection of the sides of the O-ring groove. The self-energized ring itself is capable of sealing fluid pressure equal to the ultimate compression stress of the metal itself.

Temperature reduces the maximum pressure which the O-ring can withstand in a given application in a proportion somewhat less than the effect of temperature on the ultimate stress of the O-ring metal itself. The installed O-ring has high stresses in the metal. Temperature causes the O-ring to relax, reducing the stresses. This decreases the resilience of the O-ring and decreases the force of the O-ring sides on the groove. ▼▼▼

This article was prepared from data supplied by United Metallic "O" Ring Corp. Dayton, Ohio.

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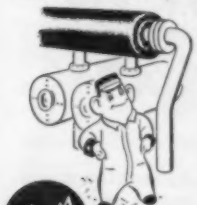

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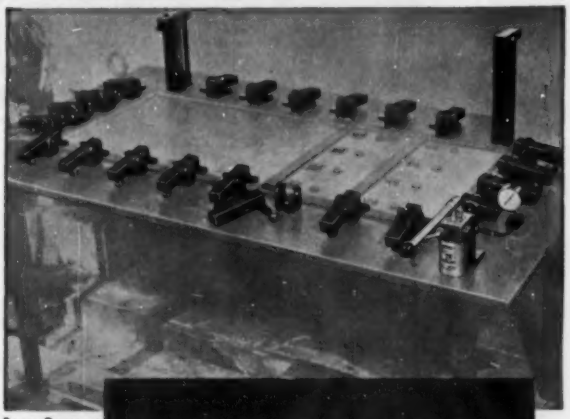
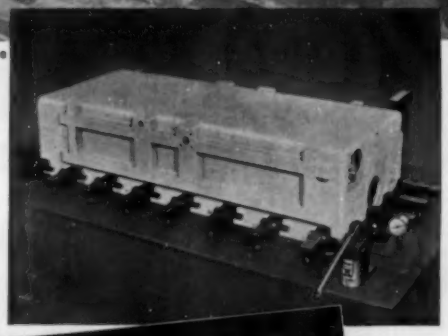


Sump Pressure Test Rig.



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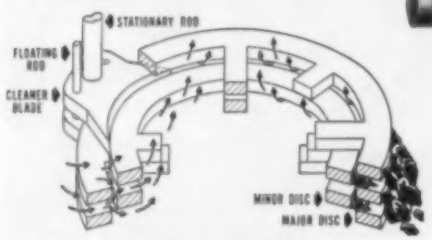

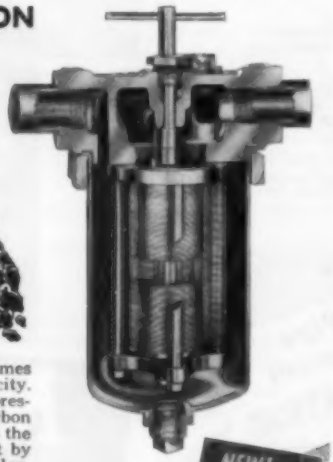

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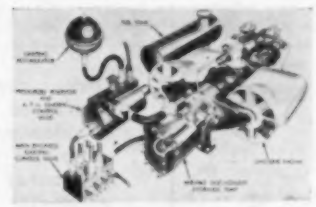

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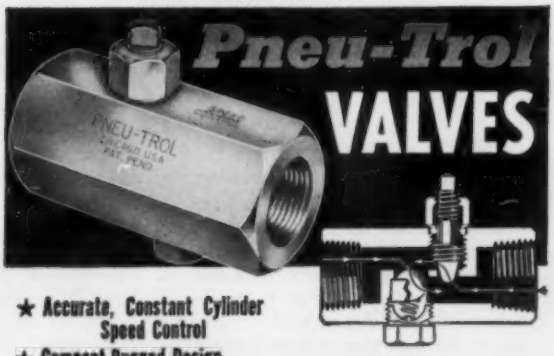

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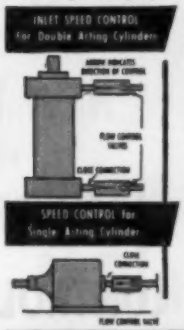

Pneu-Trol Speed Control Valves, are widely used in hundreds of control applications because they combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Retro ball floats in most sensitive position to its seat, requiring only a slight differential pressure to fully open or close it.

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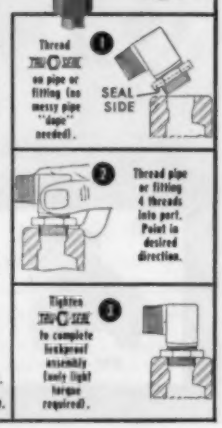
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New Products continued

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Features: Unit is available as a mobile ground unit, or as a permanent package in the aircraft. In the permanent setup, power is available while on the ground or airborne. Applications include driving small alternators, ground taxiing of rotary wing aircraft, cabin air conditioning, winch drives, surface controls. Once the starting cycle is complete, unit becomes available for use as a hydraulic pump.

Specifications: For starting a 15,000 lb. thrust engine, a starter unit capable of 27 second starting-to-ground idle time weighs only 22 lbs. Minimum size starter for a 34 second start weighs 18 lb. Complete airborne power-supply package weighs approximately 170 lbs.

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. . . has built-in relief

Designation: 660 Series

Specifications: Units have built-in pressure-relief mechanism which automatically relieves a build-up of

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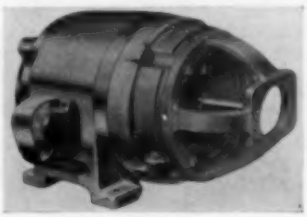
. . . offer direct pump mounting

Features: Designed for hydraulic pumps, these motors have a face-type registered bracket for mounting the pump on the motor. This method of coupling eliminates sep-



arate base plates or platforms; package is more compact; built-in alignment of pump to motor is insured; and installation time is reduced. Design of the bracket per-

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Marotta Valve Corp.
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mits easy access to the motor shaft, coupling, and pump mounting bolts.

Specifications: Type H uses drip-proof enclosure motors to 20 hp; Type SC to 125 hp; Type J and E have totally-enclosed and explosion-proof motors to 10 hp; Type SD and SE to 125 hp. For double-end installations, motors can be supplied with double-end shafts and mounting brackets for supporting two pumps. Motor windings are asbestos-protected, castings are normalized to retain machining accuracy, and ball bearings are re-lubricated by a transverse method which completely removes old grease.

U. S. Electrical Motors, Inc.
Los Angeles, Calif.

Circle 219 on Reader Service Card

AIR and OIL CYLINDERS . . . have feed ring lock

Designation: Economair

Features: Designed for air or hydraulic service to 200 psi, these cylinders use internal feed-ring locking of heads to cylinder barrels, eliminating bulky head castings.

Specifications: Flange, clevis or L-type mounting brackets are interchangeable. Construction is non-corrosive, with barrels of hard-drawn seamless brass tube, rods of

ground and polished stainless steel, and heads and pistons of aluminum. Standard cushion and non-cushion models are offered.

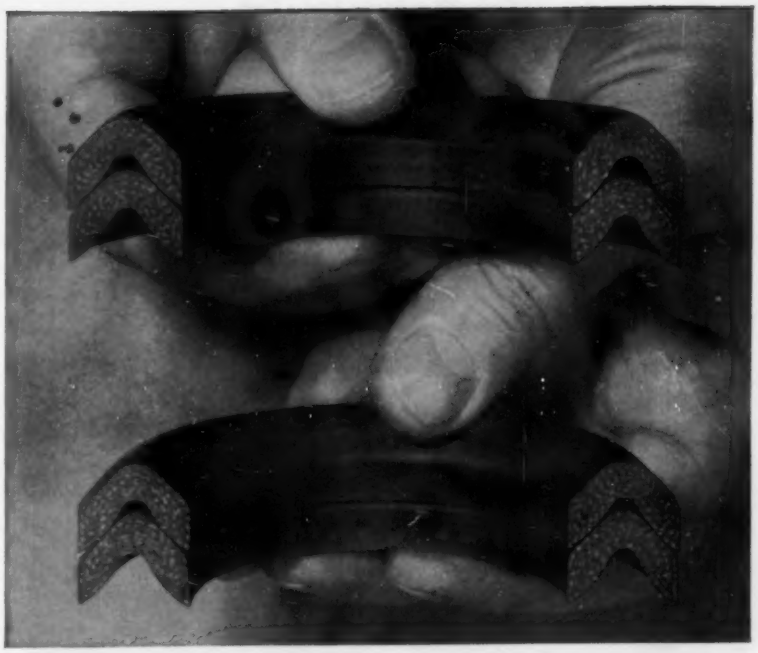
Modernair Corporation
San Leandro, Calif.

Circle 220 on Reader Service Card

LEVER SWITCH . . . locks magnetically

Features: Design features an electro-magnetically latched arrangement. After the electromagnet has been operated, the switch lever cannot be released by shock or error. This assures fool-proof operation in applications where positive action must be depended on. The locking latch is actuated by the armature of an electromagnet which is an integral part of the switch.

Continued on next page



Which V-Rings have the original Vee-Flex® design?

Appearance won't tell — performance will!

DESIGNED FOR EVERY PISTON AND ROD • ROCK-HARD RINGS • POLYMER SATURATED FABRIC • PRECISION TRIMMING • PROPER INTERFERENCE FOR AUTOMATIC SEALING

R/M Vee-Flex is so designed as to be self-sealing and self-adjusting. The surfaces of the rings have a convex curvature where they contact the ring adjacent. The hydraulic pressure stroke produces a seal laterally against the stuffing box wall and longitudinally against the next ring.

Deep, thorough penetration of the compound into the fabric of this top-flight packing enables it to provide maximum resistance to extrusion at high pressures. In addition, it is precision molded for better fit, longer service. Whatever your hydraulic application, you can count on R/M Vee-Flex for perfect performance.

R/M makes a complete line of mechanical packings, including Vee-Flex, Vee-Square, Homogeneous Vee-Rings, and Fabric Piston Cups

For complete information, send for booklet

R/M PACKINGS
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

FACTORIES: Passaic, N.J.; Bridgeport, Conn.; Manheim, Pa.; Neenah, Wis.; No. Charleston, S.C.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Mechanical Packings • Asbestos Textiles • Industrial Rubber • Engineered Plastics Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings • Brake Blocks Clutch Facings • Industrial Adhesives • Bowling Balls • Laundry Pads and Covers

Circle 157 on Reader Service Card

One leak or a thousand . . . if you have a similar frustrating experience in a metal-to-metal static sealing problem, United's Metallic O-Rings are the answer!

They fit any application calling for a positive, permanent seal against internal or vacuum pressures up to 10,000 p.s.i., in a temperature range from –70 to 1800°F. They are especially adaptable for sealing cylinder heads, air and hydraulic pressures, high octane fuels, vapors, gases, oils, solvents, chemicals, acids, vacuum and steam connections. Available in various metals and finishes, 3/8" to any size or configuration.

For free 22 page booklet describing United Metallic O-Rings, write (on your letterhead please) to Department .-2.

UNITED METALLIC "O" RING CORP.
Dayton, Ohio o Box 1035
Division of United Aircraft Products, Inc.

New Products / continued

The magnet is energized suitably at the proper point of the sequence of circuit operation. Restoring force required to move the switch lever

through the latch is so great that attention is arrested if it is attempted.

Specifications: Switch is available in any contact arrangement required up to a maximum of three make-and-break contact sets. Contact pressures are very high and limited only by strength of material used. Standard switch is 2-3/8 in long, 2 in. high and 1-1/8 in. wide, and weighs 2¾ oz. Voltage is 24 v dc on standard units, but any dc

Now! BAR STOCK BRASS HOSE FITTINGS That Give You Maximum Flow of Air and Water

Service Mfg. & Supply Co. J.I.C. union type fittings are available with 37° flare adapters—elbows are 45°, 90°, in standard and long lengths. All fittings are wide aperture and machined from top quality bar stock. This gives you non-porous and maximum flow fittings.

J.I.C. Union type

Special Design—Designing and manufacturing special fittings to your prints is our specialty. In addition, our complete stock of non-porous wide aperture standard fittings will serve your normal needs.

Solid type

Short-Runs—Designing and manufacturing short-run orders is also a specialty of Service Mfg. & Supply Co. Fittings range from any length elbows to special "Y" fittings. Write today for catalog.

"Y" fittings—Standard stock or designed from your prints.

Jobber and agent inquiries invited.

Service Mfg. & Supply Co.
315 East State Fair Detroit, 3, Mich. TWinbrook 3-6565

This AIR PRESS has positive, exact depth stops

Many job changes can be made by quick, simple stop nuts, without touching column adjustment. Rigid, solid steel column, and heavy surface-ground base.

One of nine sizes and models in the great dependable Mead Air Press line.

Write for complete information!

MEAD SPECIALTIES COMPANY
PATHFINDER IN AIR POWER AUTOMATION
4114 N. Knox Ave. Dept. AH-57, Chicago 41, Ill.

Circle 136 on Reader Service Card
Circle 103 on Reader Service Card

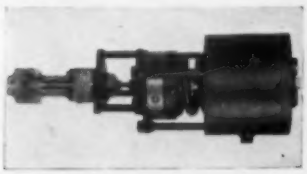
voltage up to 130 can be supplied. Switch meets exacting military requirements.

Jaidinger Mfg. Co.
Chicago, Ill.

Circle 221 on Reader Service Card

VALVE ACTUATORS
. . . for severe service

Specifications: Units are all-metal construction, designed for pneumatic and hydraulic control systems operating under difficult conditions, such as atomic radiation, high temperature and corrosion. Available with suitable valves as complete control units, or as additions to existing valve installations. Some are designed to function either air-to-open or air-to-close, and are easily reversible in the field. For use in highly corrosive atmospheres, one model is made with stainless bellows and stem and its frame



made from cold-rolled steel which is cadmium plated. Available in three ranges of signal pressures: 3 to 15; 6 to 30; and 9 to 45 psi. Units possess a maximum thrust of about 3000 lbs. and are compact in size, measuring 17-$\frac{9}{16}$ in. in length and 8-$\frac{5}{8}$ in. in diameter. The line includes smaller units and models for use in less-critical situations.

Robertshaw-Fulton Controls Co.
Knoxville, Tenn.

Circle 222 on Reader Service Card

IN-LINE RELIEF VALVES
. . . are temperature compensated

Design: Valves are designed for use in systems operating up to 4000 psi, and meet requirements of MIL-V-5523B. Tests have been run at temperatures up to 275 F, and the valves may be modified for temperatures to 650 F since they do not employ a dynamic elastomer. A built-in dash pot dampens out any tendencies for the valve to become unstable from cracking due to extremely high flow. These high-gain, high-bulk-modulus relief valves are also temperature compensated, minimizing the effect of oil temperature variation within the valves during normal operation. Area within the hysteresis loop is practically negligible, therefore the valves should have many applications in high-gain servo

systems where frequency response is important.

Specifications: Valves are furnished with AND10050, AND-10056 or MS33514 fitting ends to suit particular installation needs. Flow capacity of the ½-in. unit is comparable to the MS28887 ¾-in. valve with approximately half the pressure differential between full flow and reseat.

Arkwin Industries, Inc.
Westbury, N. Y.

Circle 223 on Reader Service Card

SOLENOID PILOT VALVE
. . . is internally cooled

Designation: Speed King

Features: Continuous internal cool-

Continued on next page

LENZ "O-RING"

NO METAL TO METAL SEAL

J.I.C. APPROVED

HELD BY FRICTION GRIP OF THESE TWO

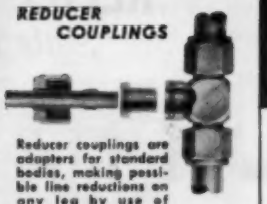
NO CONCENTRATION OF STRESSES DUE TO FLARES OR FERRULES FOR TUBE FAILURE

NO EXACT TUBE LENGTH NECESSARY

NOT NECESSARY TO CUT TUBE SQUARE

SEAL AND GRIP ARE SEPARATE

REDUCER COUPLINGS



Reducer couplings are adapters for standard bodies, making possible line reductions on any leg by use of standard adapters and adapter nuts.

. . . A Hacksaw And A File Are All You Need

Excessive wrench torque is unnecessary for seal does not depend upon tightness of the nut. The higher the pressure the tighter the grip. Solve your hydraulic piping problems the easy way . . . with ease of assembly . . . no matching of exact tube lengths . . . simple leakproof connection for the life of the tube.

Reusable collet holds by friction grip up to bursting pressure of tubing.

LENZ FITTINGS MAKE THE JOB AS SIMPLE AS A B C

See our Catalog Page in Thomas Register 1956 Edition, Vol. 1, under classification "Fittings: Hydraulic" for complete list of types and sizes.

FOR MORE DETAILS, SEE PAGES 159-162 in the 56/57 Master Catalog of Fluid Power Products

LENZ COMPANY

BOX 1044-A • DAYTON 1, OHIO

PHONE: ORegon 9364 • 3303 KLEPINGER ROAD

DISTRIBUTORS IN PRINCIPAL CITIES

Circle 91 on Reader Service Card

Circle 16 on Reader Service Card

THERE ARE NO BLOW BYS.
with the AUTO-DIESEL GAPLESS Piston Ring

Pat. No. 2,738,243

Here is a new Auto-Diesel development that is a complete departure from conventional type rings. It sets a new standard for pneumatic and hydraulic cylinder sealing. The illustration shows the patented insert that assures a positive seal and prevents blow bys. They offer 3 advantages;—(1) reduce air or oil leakage. (2) Lower the cost of compressed air. (3) You get a more positive stroke. They can be adapted for high temperatures by changing the insert.

It will PAY to INVESTIGATE..

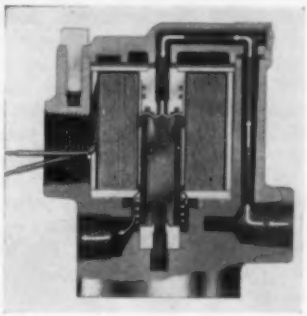
Auto-Diesel GAPLESS Piston Rings are used as original or replacement in pneumatic operated industrial equipment and for normal pressure hydraulic. They can be made a contracting ring for sealing shafts, bearings or replacing packing, etc., and many other applications. Made in sizes from 2" and up.

Write for Details

THE AUTO-DIESEL PISTON RING CO.
3137 Superior Avenue • Cleveland 14, Ohio
"RINGS and SHAPES Since 1921"

New Products / continued

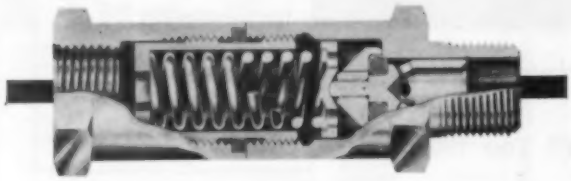
ing of the solenoid coil and self-cleaning effect of the actuating plunger prevents overheating and insures long service life. Operating medium passes through the center of the solenoid, between the plunger tube and the plunger.



Coil is completely sealed from operating medium by multiple Hycar seals.

Specifications: Stainless steel is used for seats, plunger and plunger spring. Pilots handle air, oil or water, and are available in direct, subbase or manifold-mounting; 2 and 3-way types. Solenoid coils are sup-

This
RELIEF VALVE
Seals Tight



Seals Tight To over 95% of cracking pressure provided by Circle Seal's "O" Ring sealing principle.

Relieves Accurately Opens consistently at preset cracking pressure.

Flows Freely Minimum flow restriction due to streamlined poppet and full flow ports.

Reseats Tight Zero leakage within 10% of cracking pressure.

Circle Seal Representatives throughout the United States

Circle Seal Products Co.
Incorporated
2181 EAST FOOTHILL BOULEVARD
PASADENA, CALIFORNIA

MARSHALLTOWN
THE RIGHT GAUGE
FOR YOUR
SPECIFIC
NEEDS

- PRESSURE
- VACUUM
- COMPOUND
- ALTITUDE
- COMBINATION
- DIAPHRAGM
- HYDRAULIC
- AND SPECIAL PURPOSE GAUGES
- DIAL THERMOMETERS

(Vapor Tension or Bi-Metal)

• Available in a wide variety of general purpose and special purpose gauges in pressure ranges to meet your specifications in every particular.

WRITE TODAY FOR COMPLETE INFORMATION

MARSHALLTOWN MANUFACTURING CO.
800 EAST NEVADA ST.
Marshalltown 4, Iowa

Circle 35 on Reader Service Card

Circle 100 on Reader Service Card

plied for 3 to 300 v dc and 6 to 550 v ac, 25 to 60 cycles. Coil current consumption is 0.2 amps. at 115 v 60 cycles.

Valvair Corp.
Akron, Ohio

Circle 224 on Reader Service Card

HYDRAULIC STRAINER UNIT

. . . indicates when to clean

Designation: Telltale Strainer

Features: This unit brings the strainer out of the depths of the reservoir to any convenient outside location, where it can be seen and serviced easily. Strainer indicates by a red signal when it is clogged, acts as a by-pass valve to protect the pump, provides for easy removal. When clogged, unit is pulled aside by pump suction to allow free flow of oil around it.

Automated setups can use an optional limit switch in place of the signal light. Useable oil supply is increased up to 20 per cent, as the oil inlet pipe can be lowered further into the tank.

The Rosaen Co.
Hazel Park, Mich.

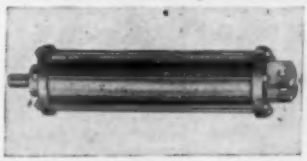
Circle 225 on Reader Service Card

AIR CYLINDERS

. . . have capsule-type gland

Features: Designed to give long life under severe conditions, units have a capsule-type gland of alloy steel with long rod guide and independently adjustable "V" rod packing. Bronze rod-wiper ring prevents foreign material from entering the cylinder. Cylinders can be completely disassembled in a few minutes using simple tools, and V-ring packings are adjustable by hand.

Specifications: Cylinder heads are cut from steel plate, and heads, clevises and pistons are cadmium plated. Piston rods are ground, precision-honed and hard-chrome plated. Operating pressures are 150 psi air and 500 psi hydraulic service. A six-tierod cage protects cylinder barrel in rough service. Units are available in strokes up to 18 feet,



3 in. through 8 in. bore, with a wide choice of piston-rod sizes.

Densmore Engineering Co., Inc.
Compton, Calif.

Circle 226 on Reader Service Card

PRESSURE LUBRICANT

. . . forms thin film

Designation: Molykote Type GX

Application: Material is a molybdenum-disulfide lubricant. Maximum effectiveness as an extreme-pressure lubricant in a grease is achieved by increasing the total surface area of the molybdenum disulfide through reduction of particle size. The decrease in particle size brings more molybdenum disulfide in contact with the metal, while the reduction in solid con-

Continued on next page

GOSHEN
GORSIL*

*Trade name for Silicone Rubber compounds custom-formulated by Goshen Rubber Co., Inc.

when it comes to SILICONE RUBBER PARTS (molded, lathe-cut or metal bonded) from CUSTOM-FORMULATED COMPOUNDS come to Goshen Rubber

MOLDED

LATHE-CUT

BONDED-TO-METAL

A wide selection of specification-standard and custom-formulated silicone rubber compounds are at your command for precision fabrication by Goshen of products requiring properties like these:

- Resistance to temperature extremes, —80° to +500°F.
- Resiliency over a range of —120°F to +600°F.
- Low compression set.
- Resistance to chemicals, oils, oxidation, ozone, weathering, moisture, fungus, corrosion, shock, abrasion.
- Freedom from stain, odor, tackiness and toxicity.
- Same shrinkage as organic rubbers, with resultant advantages.

SEND FOR LITERATURE

This 8-page brochure and technical bulletins tell how you can put Goshen Rubber to work for you. Send for your free copies today!

See our catalog in Sweet's Product Design File.

PUT Goshen Rubber TO WORK FOR YOU

GOSHEN RUBBER CO., INC., 1357 S. TENTH ST. GOSHEN, IND.

Circle 62 on Reader Service Card

tent minimizes excessive surface accumulation.

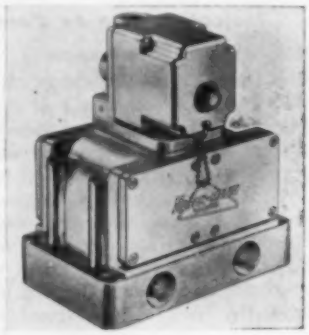
Alpha Molykote Corp.
Stamford, Conn.

Circle 227 on Reader Service Card

AIR CONTROL VALVES
. . . eliminate crossed piping

Designation: Nopak-matic

Features: Units are poppet-type, and both single and double-solenoid pilot heads incorporate an automatic flow director. This provides automatic selection of pilot air-pressure supply from whichever port is used as inlet, and eliminates use of special valves for each application, or re-assembling parts to obtain desired operation. Pilot pressure is always supplied to the control head automatically, so any 3-way valve can be piped normally-open or normally-closed to pressure simply by piping to the proper port. Any 4-way valve can be piped with pressure to either of two inlet ports, thus changing the flow pattern through the valve and eliminating criss-cross piping.



Specifications: Units have oversized passages for full flow with minimum pressure drop. Available with subplate mounting, replaceable seats, all models comply in every detail with JIC Pneumatic and Electrical Standards. Solenoids are low-amperage, continuously rated industrial type. Coils are silicone varnish impregnated and plunger faces have hardened tool-steel inserts. All parts are corrosion resistant.

Galland-Henning
Nopak Div.
Milwaukee, Wis.

Circle 228 on Reader Service Card

SLEEVE SELECTOR
. . . uses only 125 psi

Features: Unit provides electro-hydraulic control of fail-safe, closed-drive or speed-brake flaps, and operates on 125-psi pilot pressure for 3000 psi service. Spring return to neutral, augmented by actuating pressure, assures positive action regardless of contaminants or silting.

Specifications: Unit has 12-gpm capacity for ½-in. tube and is provided with integral filters and provisions for manifold or stacking. Selector was designed to oper-

Pan-Sec

A New Concept in Hydraulic Panels...

'Pan-Sec' sections bolt together easily—quickly—to make a complete hydraulic panel and Eliminates Costly Boiler Mounting Plates and Sub-Plates

only 'Pan-Sec' sections give you all these advantages

- **FLEXIBILITY** Sections can be easily added to or removed from your master panel by you at any time.
- **PRECISION MACHINED** Each section is machined to permit easy interchanging *AND* for the addition of sections to your master panel.
- **SAVES TIME** 'PAN-SEC' sections can be assembled into a master panel and piped ready for installation of valves *BEFORE* valves are delivered!
- **ECONOMICAL** Saves you money—No additional machining or engineering time required —No custom boiler plate or sub-plates needed.

PATENT PENDING

'Pan-Sec' sections can be assembled into *ANY* size hydraulic panel in multiples of 6". Shown front view of a master panel.

'Pan-Sec' standardized sections are engineered and designed for use with *ANY* J.I.C. standard gasket mounted hydraulic or air valve.

They are carried in stock ready for immediate shipment . . . can be used as individual units or bolted together to form a master panel. Valves mount directly on 'Pan-Sec' sections.

Write today

for our 'Pan-Sec' brochure . . . Gives complete information, plus how 'Pan-Sec' can be used with manifolds.

Representatives in all principal areas.

BIRMINGHAM Hydraulic Products Co.

14540 Schaefer Road, Detroit, Mich.
Telephone BRoadway 3-8047

ate at fluid and ambient temperature range of -65 F to 300 F, with operating pressure of 3000 psi. It can be produced to meet specific requirements. Unit is solenoid-operated, 4-way, 3-position.

Wm. R. Whittaker Co. Ltd.
Los Angeles, Calif.

Circle 229 on Reader Service Card

LUBE OIL ADDITIVES
. . . improve viscosity index

Designation: Omavis 10 and 20

Properties: These products combine the desired effects of raising the viscosity index and lowering the pour point. At the concentrations used in formulating multigrade oils, they give ASTM pour points of —30 to —50 F. These additives thicken the oil less for a given viscosity index level, permitting wider latitude in compounding as well as reduced use of additive. The two products are identical chemically but differ in molecular weight of the active ingredient.

Industrial Chemicals Div.
Olin Mathieson Chemical Corp.
Baltimore, Md.

Circle 230 on Reader Service Card

V-RING ADAPTERS
. . . resist extrusion

Designation: Phenol-Fab

Features: Phenolic resin and fabric are used in these adapters. When

molded at high temperature they produce a hard, tough composition that will not extrude. As a bearing material it reduces scoring of the moving member to a minimum.

Specifications: Adapters are precision molded to nominal OD and ID. With the tapered-lip design, pressure rings are automatically preloaded in the packing recess, eliminating the need for gland pressure. Male and female adapters are available in standard cross-sections of ¼, $\frac{5}{16}$, ⅜ and ½ in. up to 12 in. OD.

Perfiex, Inc.
Hazel Park, Mich.

Circle 231 on Reader Service Card

Low price and high quality make FULFLO Pressure Control Valves a natural choice for O.E.M. installation. The service they deliver . . . quiet, dependable, trouble-free . . . makes them ideal from the equipment users' viewpoint too! Available with "O" Ring or Gasket Seal.

- Standard and Flanged models
- Just 6 springs for pressures to 500#
- Cast iron or brass bodies
- Brass, steel or stainless pistons
- Pipe sizes to 2½"
- SPECIALS to your requirements

FULFLO

WRITE for "Fulflo Valves Mechanical Data Book," free helpful reference

THE FULFLO SPECIALTIES CO., Inc.
415 Fancy Ave. • Blanchester, Ohio

Circle 53 on Reader Service Card

One source for component parts really pays off...coordinated shipments, the same high quality standards, one responsibility are just a few of the many advantages. H-P-M is the source for a complete line of pumps, power units, valves, cylinders and system accessories. H-P-M's experience background in the design and building of hydraulic systems can be a real help when needed. Write today for a complete catalog. Ask for Bulletin 1101. Make H-P-M your standard for savings.

HYDRAULIC POWER DIVISION
THE HYDRAULIC PRESS MFG. CO.
Mount Gilead, Ohio, U.S.A.
A DIVISION OF KOEHRING COMPANY

HPM

NFPA

Circle 78 on Reader Service Card

Useful Literature / continued

GAGE ACCESSORIES . . . for protection of instrument internals against corrosive media and pulsations in pressures, are described in Bulletin 600 released by U. S. Gauge Div., American Machine and Metals, Inc. Folder covers accessories for various types of gages, dial thermometers and recorders. Also illustrated is a ring by which turret-case instruments can be panel mounted, together with other tools and fittings used in instrument operation.

Circle 259 on Reader Service Card

FILTERS . . . for water and aqueous liquids, are covered in Bulletin GEO-501 published by Commercial Filters Corp., Melrose, Mass. Booklet contains technical data on each model, including number of gallons filtered per minute, operating pressures, tube lengths, pipe sizes, inlet-outlet sizes, height and weight. Chart indicates pressure drop in psi across a honeycomb filter tube at various flow rates up to 6 gpm.

Circle 260 on Reader Service Card

SILICONE FLUIDS . . . are covered in Brochure 3-106 issued by Dow Corning Corp., Midland, Mich. Folder describes the physical and electrical characteristics of all leading silicone fluids now commercially available. Data is arranged in tabular form and includes such standard properties as specific gravity, pour point, thermal conductivity, surface tension, refractive index, dissipation factor and specific heat. A brief general description of each fluid is given, plus general application information.

Circle 261 on Reader Service Card

RELAYS . . . offering versatility and adaptability for machine-tool control applications, are covered in a circular issued by Arrow-Hart & Hegeman Electric Co., Hartford, Conn. Contactors can be wired using conventional screw-clamp terminals or an optional plug-in receptacle. Plug-in feature permits removal and replacement of entire unit in minutes. Interchangeable multiple-pole model converts from normally-open to normally-closed without tools. A center-position device protects against damage to the

Continued on page 182

Circle 77 on Reader Service Card

THE ORIGINAL
MONOPAK—CARTRIDGE

A complete packing unit for hydraulic or pneumatic rods or cylinders.

*Detailed literature on request.

- Easily installed or replaced.
- Needs no adjusting.
- Reduces initial machining expense.
- Longer service life.
- Includes "Seal-Guard" rod wiper.
- Low friction coefficient.
- Shock and burst proof.
- Cuts machine down-time.

HYDRAULIC ACCESSORIES CO.
24301 Hoover Rd. Van Dyke, Mich.

gagegard gagega
gard gagegard ga

PROTECT PRESSURE-SENSITIVE INSTRUMENTS . . . POSITIVELY

GG gage gard

Seals off gage or manometer connection at any pre-set pressure. Will repeat within 1% of scale. Will release 2% below cut-off point.

Models available with cutoffs from 20" water to 9000 psig. liquids and gases. Designed to withstand and hold closed against 10,000 psig.

Marine models available.

Write for Bulletin 541-G for full details and prices.

INDUSTRIAL ENGINEERING CORPORATION
325 E. Woodbine, Louisville, Ky.

Palley's SAVE YOU UP TO 85%
ON HYDRAULIC CYLINDERS-VALVES-PUMPS-PARTS, etc. . .

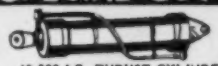
OVER 10 YEARS EXPERIENCE in filling the needs of Aircraft and Heavy Industry led to the development of our own line of outstanding INDUSTRIAL HYDRAULIC CYLINDERS and supplies. We also carry one of the largest stocks of GENUINE GOV'T SURPLUS CYLINDERS, VALVES, PUMPS, MOTORS and Accessories. What we cannot supply we will CUSTOM MANUFACTURE to YOUR specifications.

NEW Palley HYDRAULIC CYLINDERS

All are Double Action with rugged steel construction throughout. Made to stand pressures up to 1500 PSI and 3000 PSI. Utilizes standard 'O' rings in all models and has leather back-up rings in the 3000 PSI types.

PART NO.	BORE	STROKE	SHAFT	P.S.I.	PRICE
P3-4-15E	3"	4"	1-1/8"	1500	$34.25
P-6-15E	3"	6"	1-1/8"	1500	36.75
P3-12-15E	3"	12"	1-1/8"	1500	44.75
P4-5-15E	4"	5"	1-1/8"	1500	39.50
P4-8-15E	4"	8"	1-1/8"	1500	45.75
P4-5-30E	4"	5"	1-1/2"	3000	55.25
P4-8-30E	4"	8"	1-1/2"	3000	61.50
P4-12-30E	4"	12"	1-1/2"	3000	69.75
P5-12-30-1	5"	12"	2"	3000	85.00
P5-24-30-1	5"	24"	2"	3000	115.00

SPECIAL GOV'T SURPLUS HYDRAULICS

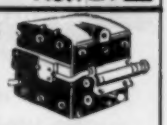


40,000 LB. THRUST CYLINDER
A GOV'T SURPLUS BARGAIN! Produces up to 40,000 lb. thrust with a 3000 PSI line pressure. May also be used as a low pressure air cylinder. Has 4" bore, 18" stroke. 30½" long. Navy overhauled— LIKE NEW — 49.95

VICKERS PISTON TYPE PUMPS
Made to top Aircraft specifications. RPM given below is recommended for constant speed.
PF9-713-20BCE — Delivers 5.3 GPM at 1000 PSI at 3000 RPM — USED $20.00
PF9-2713-10Z — Delivers 2.7 GPM at 1500 PSI at 3000 RPM — USED $22.50
VICKERS HYDRAULIC MOTOR
MF9-713-25BCF—Operates on 8.25 GPM at 1000 PSI at 3750 RPM—USED $22.50

2 GPM STRATO POWER PUMP
Positive displacement type. Capacity of 2 GPM at 1400 PSI. Displaces .450 cu. in. per revolution at 3750 RPM in either direction of rotation. Intermittent maximum RPM — 4500. Has a built-in, variable flow control valve in head. Piston type. 1 inch internal pipe ports. New 27.50

SPECIAL SURPLUS VICKERS HYDRAULIC TRANSMISSION



Self-contained, constant torque at all speeds with variable volume, reversible piston pump which supplies hydraulic motor. Has 2 H.P. automatic dash pot for smooth pressure control. Power output is 0 to 1/3 of the input RPM in both directions of rotation. Input RPM is 1800 continuous and up to 4000 intermittent. This is an excellent unit for the operation of Lathes, Duplicator Set-ups, Conveyors, Drives of all types, etc. ONLY 49.50

INPUT & TAKE-OFF PLATE ASSEMBLIES
These units permit the adaptation of a pulley input and take-off for the transmission above. They have high speed bearings and 1/2" diameter, shaft with keyway. Easily installed. 10.50 EACH

4-INCH SPLINE SHAFTS Made to fit the input and take-off shafts of the transmisson above. Permits use of gear or pulley drives. 1.25 EA.

SOON TO BE RELEASED!! 396 PAGE—1957 CATALOG

IT WILL SOON BE OFF THE PRESSES! IT'S PACKED from COVER to COVER WITH THE MOST FANTASTIC ARRAY OF BARGAINS IN PALLEY'S HISTORY!

Thousands upon thousands of Industrial, Commercial and Consumer items at GREATER SAVINGS than ever before! Tools, Supplies and Equipment in Hydraulic, Electrical, Mechanical and Building lines. Aircraft Parts and Supplies. Electric Motors, Generators and Portable Power Plants. Pumps of every description. Power Tools and so many more items it takes 396 PAGES to completely show them all. WATCH THIS AD FOR ANNOUNCEMENT OF THE PUBLICATION DATE!

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Palley's
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Los Angeles 58, California

Useful Literature continued

contacts while converting. Latching attachment allows quick conversion for use in memory, continuous-duty and similar circuits. For inspection or replacement of the coil and magnet, the entire assembly swings to the front and coil and magnet can be lifted out.

Circle 262 on Reader Service Card

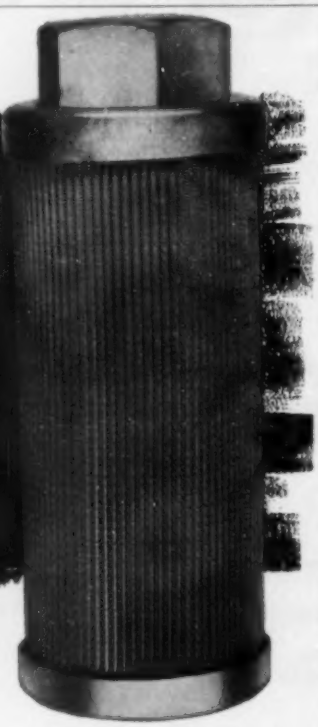
FOUR-WAY VALVE . . . oil-pressure operated by oil-pilot valve, is manufactured by Rivett, Inc. The oil-pressure feature of this hydraulic valve permits automatic operation when the oil-pilot valve is controlled mechanically. Catalog 204 gives 28 pages of detail on this valve and should be interesting to fluid power engineers. The unit requires oil-pilot lines to each end of the valve for remote operation from a pilot valve. Ball detents hold the valve piston in either end position after pilot pressure has been removed. This valve features a floating-piston design. In this construction, the valve piston has a precise fit with the valve bore, because the valve stem is independent of the valve bore. Valve stem is supported in its bearings in the valve covers with out any influence on the piston fit in the valve body. Design assures leakproof operation and smooth, positive opening and closing.

Circle 263 on Reader Service Card

Capital

HYDRAULIC OIL FILTER with Monel Metal Insert

Reservoir Type for Hydraulic and Oil Re-circulating Machinery



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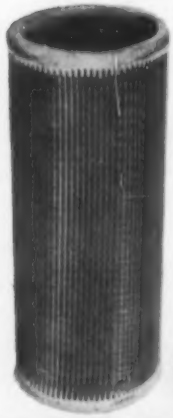
LONG LIFE—LOW COST—SIZES AND SCREENS TO FIT YOUR NEEDS



★ ONLY THREE PARTS
★ MEETS J.I.C. STANDARDS
★ GREATER FILTERING AREA
★ SPECIAL TRAP-WEAVE MESH

Specially woven MONEL wire cloth and a new method of compact corrugation, gives triple protection with less space than other filters of like capacity. Trap-weave mesh stops thin, elongated particles with NO loss of efficiency.

Non-corrosive, non-toxic materials throughout. Easily cleaned with an ordinary brush.

Write for descriptive circular.

CAPITAL ENGINEERING & MFG. CORP.

5836 SOUTH ASHLAND AVENUE, CHICAGO 36, ILLINOIS

FLARED TUBE FITTINGS . . . for fluid power service are presented in 52-page Catalog 4310 available from Parker Appliance Company's Tube & Hose Fittings Div. Booklet describes the line of Triple-lok fittings made in brass, steel, stainless steel and aluminum; and in all shapes including swivel nut type and threaded fittings with O-rings for new S.A.E. straight thread boss.

Circle 264 on Reader Service Card

SPEED REDUCER MANUAL . . . combines in one book, Bulletin 1105, complete information on The Falk Corporation's lines of concentric shaft and right angle speed reducers for applications up to 140 hp, 72,000 lb-in. output torque. Horsepower and torque ratings are given, as well as dimensions, overhung load and thrust capacities, and application pictures. Horsepower selection tables have been revised to show at a glance the standard output speeds that may be obtained with commonly used input speeds, and the full range of horsepower ratings available for each standard output speed. These reducers may be connected to the prime mover by means of coupling, belt, or chain and offer a wide range of ratios between 1.49:1 and 1459:1. Service factors are given for almost every possible application.

Circle 265 on Reader Service Card

PISTON RINGS . . . for pneumatic and hydraulic service are covered in 22-page catalog issued by the Double Seal Ring Co., Fort Worth, Tex. One section covers three-piece, segmented, cast iron and bronze rings for single and double-acting pistons. Rings are available plain or with bronze insert; in standard, inner-tongue; one,

two, or three-piece segmented; ventilated, double-scraper flexible types, or any combination of these features. Line also includes floating-type rod packing, fire-check rings, pressure breakers, double seal and oil control-rod packing. Also given is data on proper clearances in fitting piston rings.

Circle 266 on Reader Service Card

RESERVOIR RELIEF VALVE . . . featuring three rubber-bonded poppets in series, is described in Data Sheet HB-1900, issued by Manning, Maxwell & Moore's Aircraft Products Div. Unit provides reservoir pressurization control, preventing pump cavitation due to insufficient atmospheric pressure at altitude, or excessive restriction in long, small suction lines. Complete engineering information and specifications are given, along with an illustration and schematic drawing of the valve.

Circle 267 on Reader Service Card

LIMIT SWITCHES . . . operating from any angle except direct pull, and proximity switches requiring no physical contact, are manufactured by Micro Switch, Div, of Minneapolis-Honeywell Regulator Co., Freeport, Ill. Data Sheet 113 covers the flexible-actuator switch and Sheet 119 covers the proximity switch. Both sheets give complete information and specifications on the units available.

Circle 268 on Reader Service Card

AIR HOSE . . . for all types of pneumatic applications is produced by Quaker Rubber Corp., Div. of H. K. Porter Co., Inc., Philadelphia, Pa. Data sheets are available giving information, specifications and applications of air hose for all uses.

Circle 269 on Reader Service Card

RELAYS . . . and motor controls, manufactured by Ward Leonard Electric Co., Mount Vernon, N. Y., are listed in Bulletin 100,000. Models on which details and specifications are given include heavy-duty, magnetic and multipole midget; and heavy-duty and sensitive types for 125-v ac service.

Circle 270 on Reader Service Card

PACKINGS . . . for every type of fluid power service are presented in 48-page catalog published by Allpax Co., Inc., Mamaroneck, N. Y. A brief description is given of each

Continued on next page

For special pumps from stock parts

check with Brown & Sharpe

Duplex unit of Brown & Sharpe 500 Series Rotary Geared Pumps. Note simplicity and compactness. Duplex and Triplex units provide large capacity for one system or serve separate systems.

BROWN & SHARPE MANUFACTURES a broad line of gear, vane and centrifugal pumps for widely diversified uses. Frequently, a minor change in design will greatly increase the suitability of one of these pumps for your specific application.

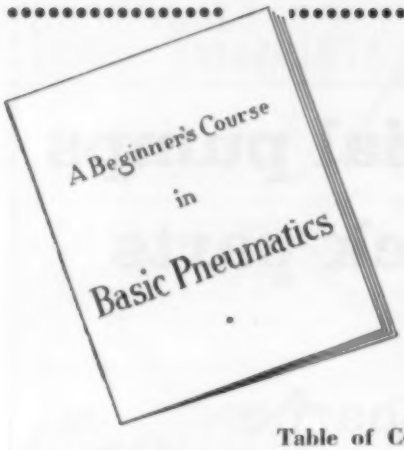
Because Brown & Sharpe pumps are precision made, many parts are interchangeable; and stock parts can often be used to create special pumps at a surprising saving in cost. We have found this to be particularly true in the case of special mountings, specially designed units comprising two or more pumps, and pumps with special internal construction.

If you are using stock pumps that cause trouble because they are "not quite right for the job" — or special pumps at too-high costs — let us know about it. You needn't take time to go into detail in your inquiry; simply ask for a copy of our "Pump Analysis Form". After you have received this form, completed and returned it, Brown & Sharpe hydraulic engineers will recommend and estimate on pumps to meet your requirements. Write to Brown & Sharpe Mfg. Co., Providence, R. I.

B·S **Brown & Sharpe**

GEAR, VANE AND CENTRIFUGAL PUMPS

Circle 25 on Reader Service Card



Again Available!

First printed in July 1954, 5000 copies of this popular booklet were bought by more than 800 companies and individuals. A second printing completed in March 1957 makes this course available to you.

$1.50 per copy

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812 HURON ROAD • CLEVELAND 15, OHIO

Useful Literature

continued

type of packing, with suggested applications. Line includes loose, coil, spool, ring, set and spiral forms, and asbestos and rubber sheet. Types are available for general service, high temperature, hydraulic or pneumatic service, impregnated and braided Teflon, high-pressure and semi-metallic packing. Also available are precision gasket-cutting tools.

Circle 271 on Reader Service Card

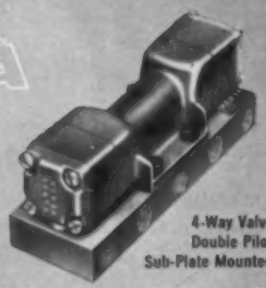
AIR CYLINDERS . . . double-acting, nonrotating type, are manufactured by Munton Mfg. Co., Franklin Park, Ill. Specifications are given on the units available, with dimensional drawings, types of mounting available and a schematic drawing of a cylinder. Cylinders meet all JIC specifications.

Circle 272 on Reader Service Card

TIMING DEVICES . . . developed by M. H. Rodes, Inc., Hartford, Conn., are presented in their Catalog Sheet BX-219. Bulletin gives basic engineering data on units in

FOR SUB-PLATE MOUNTING

VERSA
Manifold Mount VALVES



4-Way Valve
Double Pilot
Sub-Plate Mounted

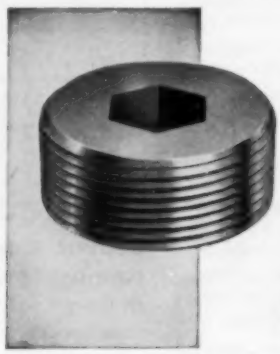
For any type of operation...there's a Versa Control Valve available for manifold mounting. These efficient, compact Control Valves are ideal for incorporation as original equipment. They can be installed directly on equipment or mounted on standard Manifold Plates (or Sub-Plates).

Versa Manifold Mount Valves are available with any type of actuating device, in sizes from 1/8" to 1" NPT, in 2-, 3-, 4-, and 5-Way Types, and for pressures from partial vacuum to 500 PSIG.

Over 110,000 Variations...
Available for Immediate Delivery!

VERSA

VERSA PRODUCTS COMPANY INC.
248A SCHOLES STREET, BROOKLYN 6, N.Y.



specify standard

UNBRAKO

Dryseal-Thread Pressure Plugs

Use them in place of ordinary pipe plugs, or wherever liquids and gases must be contained under pressure. UNBRAKOs seal without compound. They are made of the same high strength alloy steels, have fully formed threads and the same internal wrenching feature as other UNBRAKO socket screws. Standard sizes—1/16" to 1¼"—are stocked by authorized industrial distributors. Ask your UNBRAKO supplier for Bulletin 883. Or write STANDARD PRESSED STEEL CO., Jenkintown 2, Pa.

STANDARD PRESSED STEEL CO.
UNBRAKO SOCKET SCREW DIVISION SPS
JENKINTOWN PENNSYLVANIA

Circle 161 on Reader Service Card

Circle 145 on Reader Service Card

their 70,000 series. A variety of switching arrangements and features are shown on an illustrated chart. Mounting illustrations and dimensional drawings are included.

Circle 273 on Reader Service Card

HYDRAULIC ACTUATORS . . . for rotary or linear motion are described in bulletins released by Dalmo Victor Co., Div. of Textron, Inc., San Carlos, Calif. Details and specifications are given, with illustrations, schematic drawings, and graphs showing frequency response of typical actuators. Hydraulic backlash has been reduced in the linear actuator and eliminated in the rotary actuator, which has pressure on both rack gears at all times.

Circle 274 on Reader Service Card

HYDRAULIC SERVO VALVES . . . featuring high response, are illustrated and described in Catalog 120 released by Bendix Pacific Div. of Bendix Aviation Corp. Complete engineering information and specifications are given on the various units, with the details of construction shown in schematic drawings. Units are electrically actuated, two-stage, high-response hydraulic servo valves, designed with a steel body and integral steel inserts.

Circle 275 on Reader Service Card

PACKING GLANDS . . . for sealing tubes of any material, are described in Catalog 1556 released by Conax Corp., Buffalo, N. Y. Glands feature simple assembly and are available in any bore size from 1/16 to 3/4 in. Specifications given include the various types of sealants which can be specified. Also included is information on other items in the line, such as thermocouple gland sealants and insulators, safety wells, protection tubes, flex-tube assemblies and special assemblies.

Circle 276 on Reader Service Card

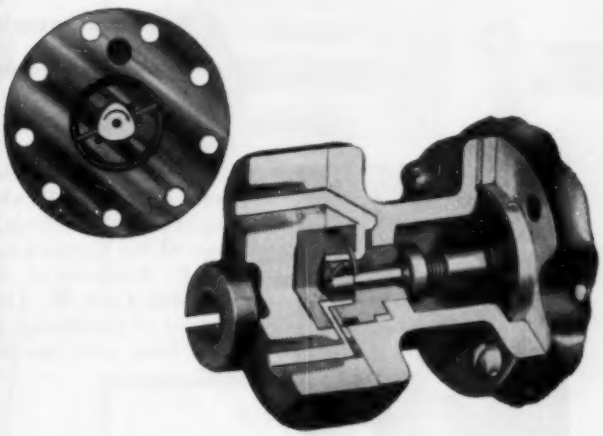
TUBE FABRICATION . . . as performed by A. B. Murray Co., Inc., Elizabeth, N. J., is discussed in their Bulletin No. 5. All forms of fabrication are available, including bending, swaging, upsetting, flame-spinning and welding. Complete listing is given of the various types of tubing available, with complete specifications.

Circle 277 on Reader Service Card

WELDON

FLUID METERING PUMPS

Positive Displacement Rotor Type. For Industrial Applications, Aircraft Anti-Icing and Aircraft Fuel.



IT'S SO SIMPLE!

The rotation of the rotor draws the fluid in through two passages, filling the cavities formed by the three lobes of the rotor. This fluid is sealed within these small cavities until it is forced through the two outlet holes by the floating blades. The flow may be kept uniformly divided through two outlet ports, or may be combined internally for passage through a single port.

Compact • Light Weight

Send for Weldon Manual and Catalog with detailed specifications and installation drawings, covering the full range of Weldon pumps in various capacities. Specify your requirements.

THE WELDON TOOL COMPANY

3000 WOODHILL ROAD · · · CLEVELAND 4, OHIO

Circle 169 on Reader Service Card

Post Scripts of Industry

News about people, manufacturers and sales organizations

Leroy E. Bonnette
Denison Engineering Division,
American Brake Shoe Co.

Thomas F. Fitzgibbon
Parker Aircraft Co.

C. M. Martenson
Bell Aircraft

Denison Engineering Division, American Brake Shoe Co., Columbus, Ohio, has announced the appointment of **Leroy E. Bonnette** as chief engineer and **Carl W. Lindahl** as director of purchasing. Both men have been with the firm since 1942.

Parker Appliance Co., Cleveland, Ohio announced the appointment of **Allied Precision Components Corp.,** 20 Park Ave., Mt. Vernon, N.Y., and **Robert B. Porter Co.,** 1804 Chiquita Place, Glendale, Cal. as distributors of Parker products. **Parker Aircraft Co.,** Los Angeles, division of Parker Appliance is expanding its facilities. The new two-story structure, occupying more than 30,000 sq. ft., will be completed by July 1, 1957. **Thomas F. Fitzgibbon** has been appointed manager of the company's hydraulic division. Fitzgibbon is now in charge of the division which he aided to establish in 1953.

Bell Aircraft and **Hydraulic Research and Manufacturing Company,** Burbank announced new appointments of company officials. **C. M. Martenson** was elected vice president and general manager; **S. A. Baker,** treasurer; and **J. R. Haber,** assistant secretary and treasurer. Martenson has been with Bell for 8 years, and Baker 15. Both have been in managerial positions with Hydraulic Research since 1954.

Watertown Division of The New York Air Brake Company has announced the consolidation of their east coast and midwest Stratopower sales areas. Both sales areas of the company have been incorporated into the eastern sales division under **Edward J. White. Joseph F. Finn, Jr.** has been appointed manager, western sales division and will direct the sales and service staff in the west coast office.

Watertown Division of **New York Air Brake Company** announced the appointment of **Donald R. Laemmermann** to the position of field sales engineer with the Stratopower Aircraft Accessories Section. Laemmermann will cover the east coast territory.

Two changes in the executive staff of the **Naugatuck Chemical Division, United States Rubber Co.,** have been announced. **Earle S. Ebers,** formerly general sales manager, has been appointed assistant general manager of the division. **Harold M. Parsekian,** who was assistant general sales manager, has been named general sales manager.

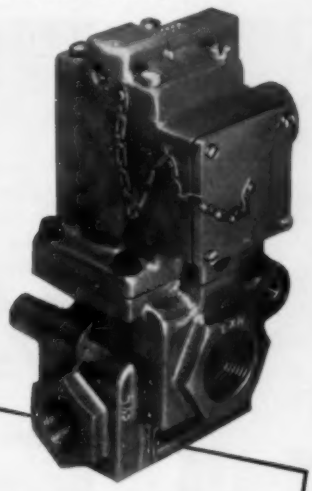
Brown & Morrison, Charlotte, N. C., has recently been appointed sales representative for **Conoflow Corp.** The firm will act as agents for ConoControls in North and South Carolina.

Continued on page 188

Circle 17 on Reader Service Card

J.I.C.
IN-LINE
3-WAY
SOLENOID
VALVES

$\frac{1}{4} \cdot \frac{3}{8} \cdot \frac{1}{2} \cdot \frac{3}{4} \cdot 1 \cdot 1\frac{1}{4}$



- NORMALLY CLOSED OR OPEN
- CONTINUOUS DUTY SOLENOIDS
- MOST A C & D C VOLTAGES

Write for Bulletin—Prices

COMPLETE LINE OF

Air Control Valves by

AUTOMATIC VALVE CO.

37415 GRAND RIVER AVE • FARMINGTON, MICH.

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PNEUMATICS SHEFFER HYDRAULICS

HYDRAULIC CYLINDERS

C4 H Series

2000-3000 psi
All Steel Construction
Meets or Exceeds J.I.C.
11 Bore Sizes—1½—12
Removable Rod Cartridge
Finest of the "Interchangeables"

Write for Bulletin #1256

THE SHEFFER CORP.

CINCINNATI 16, OHIO

MOST COMPLETE LINE OF CYLINDERS IN THE INDUSTRY

SOME TERRITORIES OPEN

HANDY HOSE

No expensive alignment. No hidden strains to work loose. With Mayson Hose Swivels you merely plug it in. Twist strain gone too.

What is it costing you not to use hose?

MAYSON MFG. CO.

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INSTANT PRESSURE REGULATION

0 to 3000 PSI

Proven Superior in Comparative Tests

WITH THE *Futurecraft* **HI/LO HAND LOADER**

Futurecraft CORPORATION

1717 N. Chico Ave. • El Monte, Calif.

WRITE TODAY for complete details

GENERAL SPECIFICATIONS	
Port Size	¼" tube per AND 10056
Pressures	Operating—100-3000 psi Proof—6000 psi Burst—7500 psi Minimum
Flow	Exceeds any other loader available
Operating Temperatures	— 65° to + 250°F
Weight	2½ pounds

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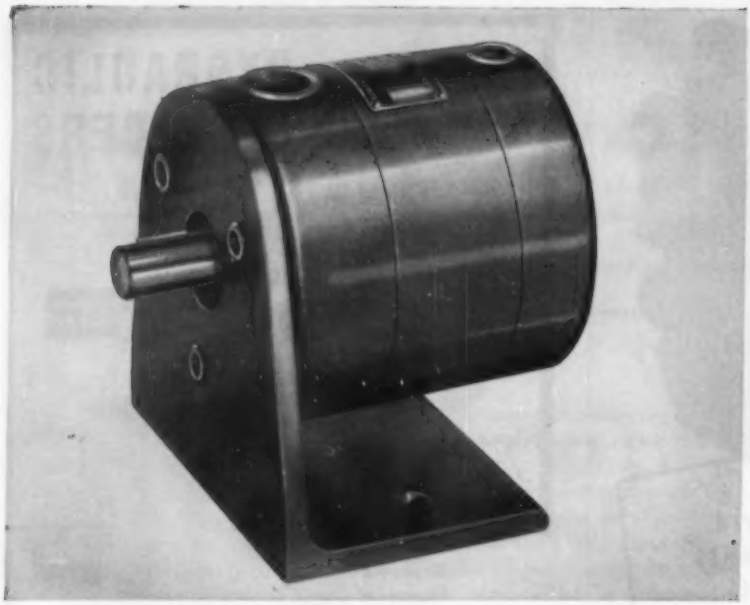
Circle 55 on Reader Service Card



a new

LOW-PRICED

radial piston pump

Here is a hydraulic pump that provides the high performance characteristic of piston-type pumps—at a price usually associated only with pumps of vane or gear design.

This is made possible by utter simplicity in design, coupled with a revolutionary "shrink seal" feature, and the economical SECO radial design.

The Model D-5 illustrated is rated at 2000 PSI maximum—5 GPM—at 1800 R.P.M. using 235 SSU oil at 100° F. *The over-all efficiency is above 90% for a wide range of operating conditions.*

A simplified feed-back control with external valving can be utilized to accomplish variable displacement—with resulting advantages, such as constant pressure feed-back control, economy in horsepower, etc.

If you use vane or gear type pumps within the range of this new pump, please use the Reader's Service Card for more complete information and prices—

SECO SERIES "D" PUMP

SIMPLEX ENGINEERING CO.

ZANESVILLE, OHIO

Post Scripts of Industry continued

Appointment of **W. Gordon Jarvis** as manager of mobile sales has been announced by **New York Air Brake Company's Kalamazoo Div.**

W. Gordon Jarvis
Kalamazoo Div.
New York Air Brake Co.

Tube Reducing Corp., Wallington, N.J. elected **A. J. Williamson** president. Formerly executive vice-president, Mr. Williamson joined Tube Reducing as a vice-president in 1951. They also announced the appointment of **Industrial Products Sales, Inc.** as sales agency for their rock-drawn tubing line. The new agency will cover Ohio, western Michigan, and northern Kentucky.

A. J. Williamson
Tube Reducing Corp.

Linear, Inc., Philadelphia, Pa., announced the appointment of **Gunner M. Oleson** as controller, succeeding **Thomas M. Hopely** who recently resigned. **Willard T. Davis** was appointed manufacturing manager.

Ray Conner
Vickers, Inc.

M. A. Hayden
Vickers, Inc.

R. E. Esch
Vickers, Inc.

Ben W. Badenoch
Vickers, Inc.

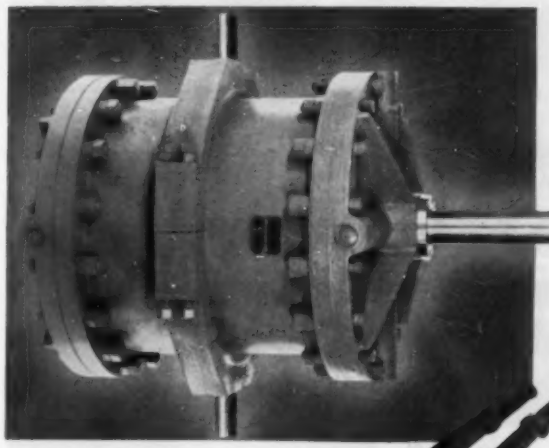
Four additional operating divisions of **Vickers, Inc.** have been announced. Each has its own engineering, manufacturing, marketing and service facilities. The new aero hydraulics division will have **Ben W. Badenoch** as general manager and **John T. Burns** as general sales manager. The machinery hydraulics division will have **M. A. Hayden** as general manager and **W. F. Driver** as general sales manager. The mobile hydraulics division will have **Ray Conner** as general manager and **Al Lane** as general sales manager. The new international division will be headed by **R. E. Esch.** During recent years Esch has been general sales manager.

U. S. Gauge, Division of American Machine and Metals, Inc., announced the appointment of three new distributors. They are: **Truesdell Co.,** 790 So. Broad St., Newark, N.J., **Ray Welch Co.,** 6346 Columbia Ave., Hammond, Ind., and **Brian Engineering, Ltd.,** 5275 Van Horne Ave., Montreal, Canada.

Continued on next page

Air & Hydraulic Cylinders

• FOR HEAVY-DUTY APPLICATIONS OF ALL TYPES • TO MEET ALL SIZE AND PRESSURE REQUIREMENTS • BORES TO 32" DIAMETER • STROKES OF 50 FT. AND LONGER.



Stroke—13½ Inches
Diameter—24 Inches
200 P.S.I. Air Pressure

Stroke: 34 Ft.
Diameter: 7 In.
1500 P.S.I.

Write today for Lincoln's catalog. It gives engineering data on many types and sizes of heavy-duty cylinders.

Lincoln Machine Company will design, engineer and build standard or special hydraulic and pneumatic cylinders with trunnion, rod-end flange, blank-end flange, foot, clevis or centerline mountings.

Call on Lincoln when you require large, powerful rotating or non-rotating hydraulic and air cylinders, heavy-duty mill-type cylinders. Our engineering department will give you fast, practical assistance in design problems . . . and our modern plant will build your cylinders quickly and economically.

LINCOLN MACHINE CO. INC.
P. O. BOX 272 • SALEM, OHIO

Circle 40 on Reader Service Card

RUGGED, HEAVY-DUTY
HYDRAULIC CYLINDERS

Attention: O. E. M.
Prompt delivery on any quantity . . . high quality . . . low cost!

Built-in Mechanical Stroke Control

Free catalog and engineering survey, no obligation.

WRITE...PHONE...WIRE

CROSS MFG. CO.

LEWIS ■ PHONE 81 ■ KANSAS

Post Scripts of Industry

continued

Resistoflex Corp. sales and assembly operations are now available in the Dallas, Texas—Tulsa, Oklahoma area. The new southwest division is at 135 Glass St.,

C. C. Cozzens
Resistoflex Corp.

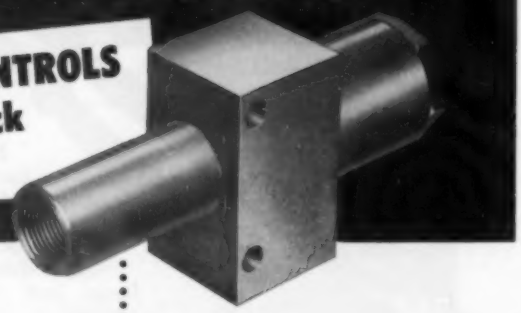
Dallas, Texas. **C. C. Cozzens** is manager of the new division.

Oilgear Co., Milwaukee, Wis. has announced the following appointments: **Ewald H. Parduhn,** district manager of the newly opened territory office at 6589 Main St., Buffalo, N.Y., **Carl L. Gosewehr,** district manager of pacific coast offices, and **Roland C. Hurtienne** as district manager of the Seattle office.

C. E. Willis, vice president and general manager of the **National Water Lift Company, Division of Cleveland Pneumatic Tool Company,** Kalamazoo, Michigan, announced an acceleration of their expansion program. The new structure will add an additional 45,000 sq. ft. of office and factory space to increase their manufacturing capacity by 50 per cent.

For Positive Leakproof Locking Of Cylinders Or Circuits Specify...

FLUID CONTROLS Pilot Check Valves



■ RUGGED — long trouble-free life

■ LOW PRESSURE DROP

- For oil to 3000 P.S.I.
- ¼", ⅜", ½", and ¾" Pipe Sizes

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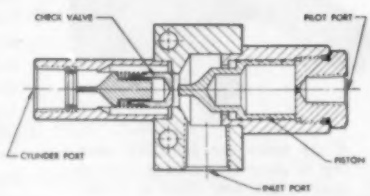
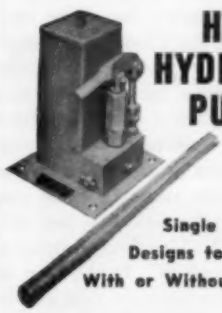


Fluid Controls, inc.

Manufacturers of Hydraulic Valves and Devices

Relief Valves • Check Valves • Restrictor Valves
Needle Valves • Pilot Check Valves • Special Valves
Pressure Compensated Flow Regulators

1284 N. CENTER STREET • MENTOR, OHIO



HAND HYDRAULIC PUMPS

Single and Double Designs to 20,000 PSI With or Without Reservoir

160 Cubic Inch Reservoir with 8" x 8" Base Plate. Optional Size Piston: ⅜", ½", ¾", 1".

Handle length: 18 inches

Catalog No. 160

We specialize in hand pump units to operate in temperatures from minus 65F to plus 160F and with any capacity reservoirs required.

The single pump with ½" or ¾" piston now available in stainless steel.

WILLIAM S. PINE

Hydraulic Hand Pumps for 1001 Uses

1635 E. 22nd St., Los Angeles 11, Calif.

Circle 51 on Reader Service Card

Circle 118 on Reader Service Card

Chester S. Beard heads the control valves and actuators engineering division of **General Controls Co.**, Glendale, Calif.

Chester S. Beard
General Controls Co.

Fuller Co., has begun expanding its Catasauqua, Pa. manufacturing facilities. With completion in summer, the plant will have doubled its production space.

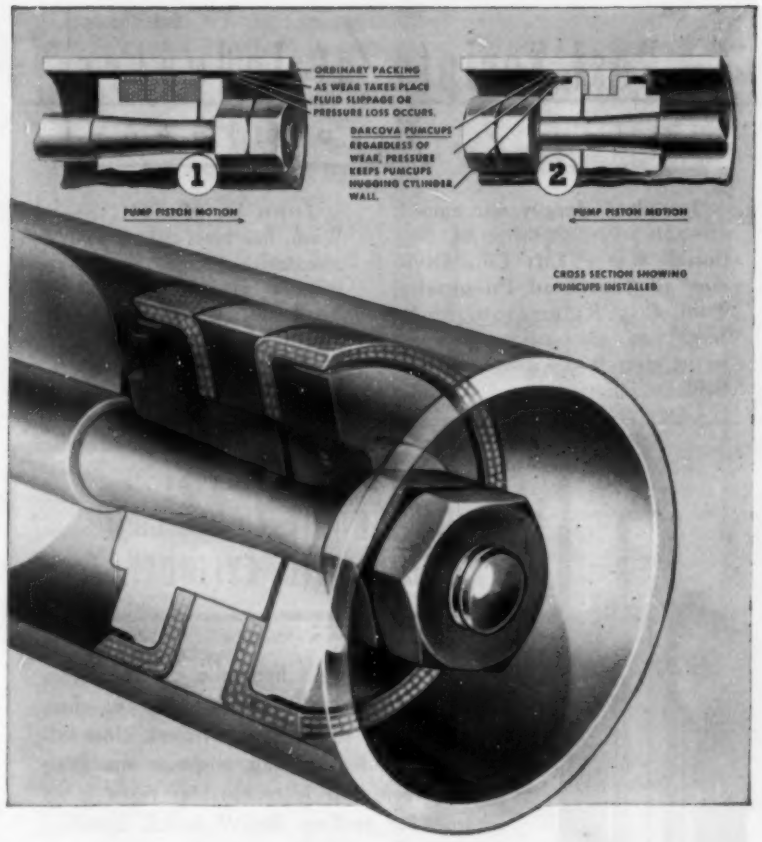
John C. Wallace has been named vice-president of engineering for **Walworth Co.** Wallace was formerly vice-president and general manager of Hunt-Spiller Mfg. Corp., Boston.

Arkwin Industries, Inc., New York, N. Y., has named **George Bales** vice president of engineering. Bales was formerly chief of research and development.

George Bales
Arkwin Industries, Inc.

Teller Co., Butler, Pa., has appointed **Charles L. Zoltani** chief engineer for its special machinery division. The division is concerned with industrial automation and plant mechanization.

Continued on next page


ORDINARY PACKING
AS WEAR TAKES PLACE FLUID SLIPPAGE OR PRESSURE LOSS OCCURS.
DARCOVA PUMCUPS REGARDLESS OF WEAR, PRESSURE KEEPS PUMCUPS HUGGING CYLINDER WALL.
1
2
PUMP PISTON MOTION
PUMP PISTON MOTION
CROSS SECTION SHOWING PUMCUPS INSTALLED

DARCOVA PUMCUPS mean EFFICIENCY to cost-minded engineers!

IN air and hydraulic cylinders and reciprocating pumps Darcova Pumcups actually retain full efficiency *throughout* their life span . . . and they outlast most other packings at least 3 to 1!

Special texture engineering plus the Darcova Pumcup principle makes it possible for Pumcups to hold their peak volumetric efficiency. Moreover, Pumcups permit equipment to be operated at reduced speeds, save power, prolong equipment life and eliminate the need for frequent replacement shutdowns.

For less maintenance and lower operating costs find out more about Darcova Pumcups. Write for Bulletin No. 5503 on Pumcups for air or hydraulic mechanisms and reciprocating pumps.

DARLING VALVE & MANUFACTURING CO.
Williamsport 15, Pa.

DARCOVA
THE ORIGINAL COMPOSITION CUP
PUMCUPS

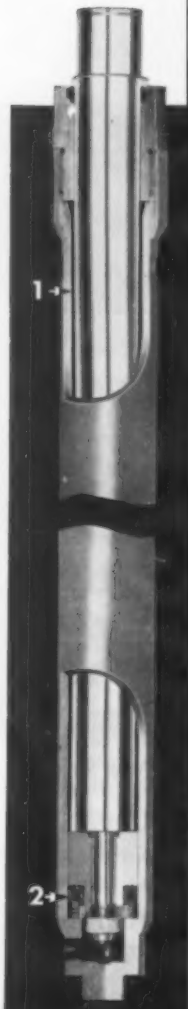
Circle 42 on Reader Service Card

Post Scripts of Industry continued

Joseph J. Jerger was named director of engineering at **National Water Lift Co., Division of Cleveland Pneumatic Tool Co.**, Kalamazoo, Mich. Jerger has done considerable work in the aircraft and guided missile field.

John D. Morell, Seattle, Wash. has been named sales representative of the industrial distributor division of **Weatherhead Co.** Morell will represent the company in Washington, Oregon, Idaho, Montana, and Wyoming.

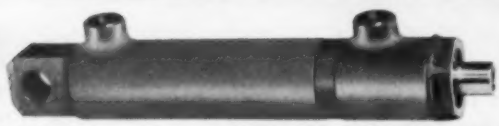
Good Design Deserves . . .
B H E W Custom-Built
HYDRAULIC CYLINDERS



BHEW custom-built hydraulic cylinders give dependable operational performance wherever they are used. These efficient, close-tolerance cylinders require minimum mounting space; their cost is reasonable; there is no charge for tooling. BHEW builds cylinders to meet your specifications, delivers them on schedule.

BHEW CYLINDER FEATURES:

Standard and special designs available. • Double or single acting and telescopic. • 1½" to 8" bore. • Strokes up to 156". • Smallest possible O. D. and retracted O. A. length. • Oil cylinders with 1,500 psi or 3,000 psi working pressure, pneumatic up to 150 psi. • Cup-type, ring-type or O-ring construction. • Choice of mounting.



1. Honed steel cylinder.
2. Full double-sealing "U" cup packing.

Furnished in a wide variety of mountings and anchor brackets.

Our engineers will be happy to work with you on any cylinder problems you may have. Without charge, of course.

Send us specifications of your requirements, for full information.

B H E W BENTON HARBOR ENGINEERING WORKS, INC.
422 LANGLEY AVENUE • ST. JOSEPH, MICHIGAN

Gerotor May Corp. announced the appointment of **Elmer J. Boehs** as general sales manager and **Horace A. Sevier** as chief engineer. Prior to joining Gerotor, Boehs was associated with Westinghouse Air Brake Corp. Sevier has been with Gerotor for a number of years as assistant chief engineer.

Clark Controller Company has completed arrangements to purchase a 170,000 sq. ft. building at 10101 Woodland Avenue, Cleveland, Ohio. They will utilize the new building for expansion of their manufacturing and warehousing capacity.

Appointment of **Edmund C. Sulzman** as general sales manager, aviation and ordinance division, was announced by **Weatherhead Co.**, Cleveland. Sulzman was formerly with Jack & Heintz, Inc.

Edmund C. Sulzman
Weatherhead Co.

J. F. Forster was named executive vice president of **Vickers Inc.** Forster came to Vickers from Sperry Gyroscope in 1941.

J. F. Forster
Vickers Inc.

Appointment of **Thomas E. Wood** to the position of director of programming and development was announced by **Flick-Reedy Corp.**, Melrose Park, Ill. Wood will direct employee relations and field communications for **Miller Fluid Power Division** and **Tru-Seal Division.**

Babcock & Wilcox Company's Research Center is to be expanded. The new building will contain 15,700 sq. ft. of floor area. The Company's Tubular Products Division has opened a new district sales office in Atlanta, Ga. **William Lehr** has been appointed to manage the new office.

Devoted exclusively to manufacture of airborne hydraulic systems and components, this 130,000 sq. ft. **Vickers Inc.** plant at Jackson, Miss. began production early in January. This new facility has the latest precision-type machinery and equipment, and adds capacity for airborne products, for which demand has increased along with the rapid growth of the fluid power industry.

increase your earnings

Sell complete line of air and hydraulic cylinders to equipment manufacturers and users in Chicago and surrounding area.

Territory available to direct man or manufacturers' representative.

Write, wire, or call:

HYDRO-LINE MFG. CO.
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ROCKFORD, ILLINOIS

Phone: 7-5758
Attention: John Harding

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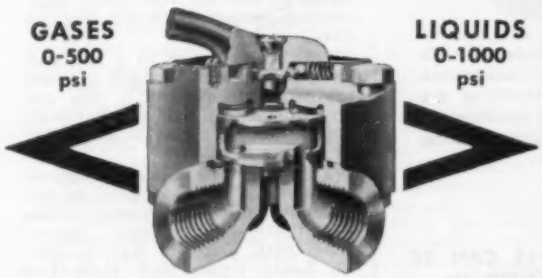
New **SEAL-TITE VALVES**
PRESSURE BALANCED

GASES 0-500 psi



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- 1/8" to 1" FPT
- −65° to 160°F
- 2, 3, 4-way
- Turning ease
- Zero leakage
- Increasing pressure tightens seals.
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Low Cost... Compact... Powerful... Rugged

AIR-MITE Cylinders—made in single or double acting series—in 4 mounting types, are high quality cylinders at a low price. Simple, rugged design and compact construction give them long life, permit easy mounting on jigs, fixtures, tools, or machines. Used wherever power holding, pushing, pulling or lifting is required, AIR-MITE cylinders will meet your most exacting standards of dependability and long life. Write for complete catalog and prices.

1. Ground and polished steel ram
2. Brass, true-bore cylinders
3. High strength aluminum alloy cylinder heads
4. Bronze oilless ram bushing
5. Five steel tie rods
6. Brass hose stems

4 Mounting Types

AIR-MITE Devices, Inc.
4401 W. KINZIE • CHICAGO, ILLINOIS

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NOW . . .

high efficiency

Filters, Regulators, and Lubricators
for Air Supply to Pneumatic Equipment

with the NEW

WATTS **high efficiency** LINE

consisting of:

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high efficiency
FILTER

New **TORNADO ACTION**

Contoured inlet eliminates drastic air pressure drop and forces the air into a downward spiral. This "Tornado Action" sets up centrifugal force which spirals dirt and moisture particles downward into the "quiet zone."

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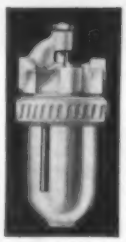
high efficiency
REGULATOR

New **ASPIRATOR ACTION**

Watts Aspirator control acts directly on input valve, giving instant compensation for fluctuating pressure demands . . . provides precise control and stabilizes pressures reaching individual pieces of equipment.

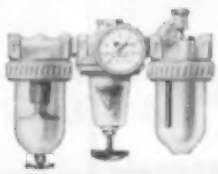
WATTS
high efficiency
LUBRICATOR



New **BY-PASS PICKUP**

Watts new By-Pass Pickup makes possible an exclusive high velocity venturi section which vaporizes virtually 100% of the metered oil. By-Pass permits maintenance of constant pressure in the venturi section with minimum pressure loss.

Complete range of Sizes: 1/4", 3/8", 1/2"



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THE MARKET PLACE

When replying to a box number in the Market Place, address your letter to Applied Hydraulics, 812 Huron Road, Cleveland 15, Ohio. Attention: Box No.

HYDRAULIC SALES ENGINEERS

Excellent opportunities for sales engineers experienced in applications and sales of fluid power equipment to sell HYDRECO Pumps, Valves, Cylinders to OEM market. Several open territories. Salary.

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The New York Air Brake Company
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TOOL ENGINEERS
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Ever thought of yourself as a SALES ENGINEER?

We are looking for men with plant engineering, tool engineering, maintenance engineering, or, possibly, sales engineering experience. Friendly, affable, likable men between 28 and 40, with sound engineering educations would suit us fine.

If you feel you are in a rut, and have given some thought to sales engineering work, or if you are now in sales but are unhappy with your set up, you may be interested in talking to us.

We are a well known company whose name is a *buy*-word in our industry and we need men in places like Cleveland, Chicago, Dayton, Cincinnati, Detroit, New Jersey, St. Louis, Upper New York, Los Angles, Dallas, or may be just where you are. Pick a spot. Your starting salary will be generous but naturally it will depend on your experience and background, together with your estimate of how long it will take for you to really get going in the sales field.

Why not spend a few minutes now to tell us about yourself? If you have the prerequisites you'll be answered and interviewed in the near future. This could lead to an entirely new business life for you, a challenging job in the fluid power industrial field.

Write to Tom Jones, Box 2557, APLIED HYDRAULICS, 812 Huron Rd., Cleveland 15, Ohio.

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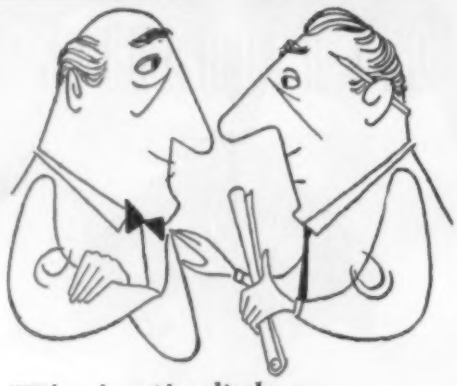
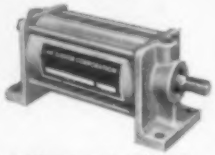


"When he said cylinders, I said Sheffer—for sure!"

. . . because Sheffer is the economy line that costs less to buy and operate. Sheffer air and hydraulic cylinders are easier to install, simpler to service. And in most cases, one order from Sheffer fills all your needs.

FULL RANGE OF STROKES AND PRESSURES.

Write for Bulletin #257 giving complete data on C-20 series air cylinders.



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MOST COMPLETE LINE OF CYLINDERS IN THE INDUSTRY

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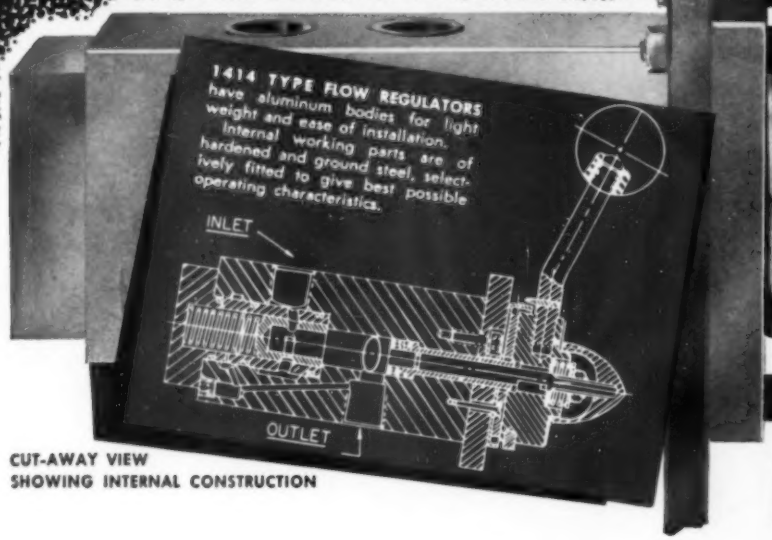
ADJUSTABLE FLOW REGULATOR

Designed for Panel Mounting

LOOK TO WATERMAN FOR THE ANSWER TO YOUR FLOW CONTROL REQUIREMENTS


1414 TYPE FLOW REGULATORS have aluminum bodies for light weight and ease of installation. Internal working parts are of hardened and ground steel, selectively fitted to give best possible operating characteristics.
INLET
OUTLET

CUT-AWAY VIEW
SHOWING INTERNAL CONSTRUCTION

Waterman Engineering Company have combined in this new Adjustable Flow Regulator all the best, improved features . . . at the same time adapting it to Panel Mounting.

Increases the flexibility of your hydraulic systems . . . ideal for installations requiring frequent changes in operating speeds.

Affords a variable adjustment of flow rate over a wide operating range.

Write for illustrated bulletin A describing the many features of this Adjustable Flow Regulator such as right or left rotation of control handle, 180° handle rotation, pressure drop, regulated flow tolerance, etc.

WATERMAN ENGINEERING COMPANY

725 CUSTER AVENUE EVANSTON, ILLINOIS.

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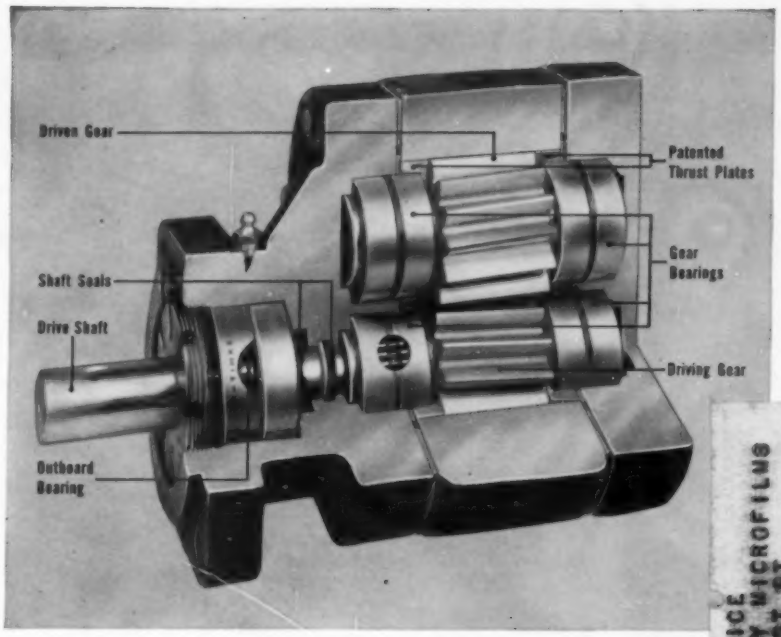
ADVANCES IN HYDRAULIC PUMP DESIGN



STEVENS RICE
UNIVERSITY MICROFILMS
313 N FIRST ST
ANN ARBOR MICH
A1J9

Oil leakage controlled

In any method of mounting an oil-hydraulic pump there is always a certain amount of misalignment between the pump drive shaft and the shaft on the power source. Even where universal drives are utilized there is still the danger of a thrust load. Result in both cases: Flexing is transmitted into the pump seal and eventually to the bearings supporting the gear—leakage around the shaft is a sure-fire bet to follow.

At Commercial, by using an outboard bearing to protect the seals and internal bearings, the common leakage nuisance is eliminated.

Internal alignment perfected

Mass production of independent gear pump housing parts invariably results in varying degrees of internal misalignment—regardless of dowel pin control points used in machining. In many cases the "out" for the problem involves a loosening up on the internal tolerances —with a resultant loss in efficiency.

At Commercial, the patented thrust plate serves as a "natural" alignment control point—is counter bored on its face to match the bearing sleeve, then fits over the bearing sleeve and in turn pilots inside the gear housing. Perfect internal alignment—and increased efficiency—in any Commercial oil-hydraulic pump is axiomatic with rigid inspection of the thrust plate alone.

Constant volume assured

The principle of automatic adjustment of end clearance by internal pump pressure had one main weakness. The full pump pressure was applied against the whole area of each thrust plate. The plates would wear unevenly because on the inlet side of the pump the plate had full pump pressure on one face and a vacuum on the gear side.

By "pressure pocketing" Commercial insured that the pressures on opposite faces of the thrust plates would be in approximate balance around the entire area of the plate faces. Commercial's "one-two" advance design punch—the patented "pressure pocketed" thrust plate—assures constant volume at any pressure and at the same time helps to maintain simplicity of design and soundness of construction . . . provides for longer operating life and no maintenance headaches.

Seizing eliminated

Commercial oil-hydraulic pumps cannot seize because of heat induced by high speed or even inadequately piped systems. Variable end clearance and positive internal alignment make seizing practically impossible. Bearings evenly loaded throughout their length—no corner loading or spawling —are able to withstand much higher operating pressures. They stay in service longer too—regardless of pressures involved.

To take full advantage of tight internal tolerances Commercial designs, produces and grinds its own rotating gears—is able to hold extra close tolerances on tooth contours, outside diameters, and concentricity.

Over 5,000 different pump combinations—port locations and sizes—can be built from Commercial's standard line of oil-hydraulic pump components. A wide variety of drive and mounting combinations are able to solve virtually any indi installation, piping and power cation requirement.

Engineering help available

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ENGINEERING DATA FREE

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